

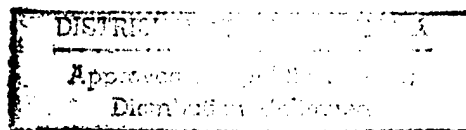


DETERMINING THE CHARACTERISTICS OF THE
AIR FORCE TELECOMMUTING PROGRAM

THESIS

Joseph L. Wolfkiel, Captain, USAF

AFIT/GIR/LAL/98S-14



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DEPARTMENT OF THE AIR FORCE
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Wright-Patterson Air Force Base, Ohio

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THESIS

Presented to the Faculty of the Graduate School of Logistics
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In Partial Fulfillment of the Requirements for the
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Joseph L. Wolfkiel, B. S.

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September 1998

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Joseph “Red” L. Wolfkiel

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Abstract

In 1994, concern about the welfare of families of workers in the federal government prompted President Clinton to issue a memorandum to executive departments calling for the implementation of a “family-friendly” workplace by implementing a variety of programs including telecommuting. This thesis explores advantages and disadvantages to be realized from telecommuting, along with developing a linear regression model that identifies factors correlated with preference for telecommuting among Air Force personnel.

This thesis uses a stated preference model derived from existing telecommuting research to characterize the factors impacting the preference for civilian, officer, and enlisted Air Force personnel. The regression models developed showed that factors affecting telecommuting preference were different among different sub-samples. Two factors were universal across the sample. Those were “Amount of Telecommuting Job Allows,” and “Allow More Work Done.” These two factors gave R-squared values of over .39 for each major sub-group in the sample. Another significant finding was that telecommuting preference was significantly greater than the amount of telecommuting the job allowed for the entire sample. The discussion includes tables and text, for use by decision makers, describing cumulative amounts of the sample who felt their jobs would allow each amount of telecommuting, along with potential advantages and disadvantages for that amount of telecommuting. This research showed that a linear method can be used to model telecommuting preference and obtain statistically significant results.

DETERMINING THE CHARACTERISTICS OF THE AIR FORCE TELECOMMUTING PROGRAM

1. Introduction

Problem Background

In 1994, concern about the welfare of families of workers in the federal government prompted President Clinton to issue a memorandum to executive departments calling for the implementation of a "family-friendly" workplace by implementing a variety of programs including telecommuting (Clinton, 1994). The president followed with a 1996 memorandum directing executive departments to develop a plan to implement family-friendly practices to include (among other programs) flexible hours to support family involvement and opportunities to telecommute, when possible (Clinton, 1996).

The directive from President Clinton forces the Department of Defense (DoD) to respond with its plans regarding a telecommuting program. In support of the DoD, the Air Force must now ask, what should our response be to the President's directive? Since the goal of increasing telecommuters from the current government-wide total of approximately 9,000 to a total of over 60,000 by the end of 1998 and a final goal of over 160,000 by 2002 (Durkin, 1997) covers a wide variety of agencies, it is possible that the goal could be met without a substantial contribution by the Air Force. Since the directive mandates a response, the Air Force must evaluate exactly what it wants to do about telecommuting. At this point, an evaluation must be made of the different aspects of a telecommuting program. These different aspects include the advantages and

disadvantages of telecommuting both for the Air Force and for Air Force personnel. Other aspects involve the form that an Air Force program could take and the Air Force's success in enrolling personnel in the program once implemented. The federal program is expected to address management and policy-related challenges. Specific issues to be addressed include limited funding, customer service, employee needs, energy consumption, air quality and global warming, and traffic congestion and safety (President's Management Council, 1996). A key decision to be made is whether the Air Force should implement a telecommuting program at all.

The remainder of this chapter explores issues relevant to an Air Force telecommuting program. The chapter includes a discussion of the term "telecommuting," trends driving telecommuting in the United States in general, advantages and disadvantages of telecommuting for the Air Force, advantages and disadvantages of telecommuting for Air Force personnel, and an overview of how this thesis will attempt to contribute to shaping the Air Force's telecommuting program.

Definition of Terms

The particular definition of telecommuting that the Air Force chooses will limit the set of responses that it can make to President Clinton's memoranda. The President's Management Council defines telecommuting as "Working in an environment outside of the traditional office one or more days per week" (President's Management Council, 1996). Given this broad definition, the Air Force may choose to look at telecommuting in a variety of ways. Mokhtarian provided a more thorough set of definitions. She divides telecommuting into two categories: home-based and non-home-based. Home-based telecommuting includes running a business from the home, moonlighting, working

at home after hours, and full-time work at home in lieu of the office (i.e., classical telecommuting). Non-home-based telecommuting includes working from a telecommuting center, fieldwork, working while traveling, and remotely managing a branch office (Mokhtarian, 1991). Gray, Markus, and Westfall (1996) advocate adding an additional definition, which allows for telecommuting for any part of the work day instead of remaining in the traditional paradigm of either full-time work at home or only after-hours work. The vagueness of definition used by the President's Management Council allows for full-time work at home, after-hours work at home, and some combination of work at home and the office for any given day. The need to define exactly what level of telecommuting the Air Force should adopt is the driving force behind this thesis.

Trends Driving Telecommuting in the United States

According to a Newsbyte Magazine, KMPG Peat Marwick LLP found that 23%, of Fortune 1000 companies have employees who regularly telecommute either full-time or part-time (Pietrucha, 1997b). The pattern of telecommuting has been increasing, but not at the rate predicted by early advocates of telecommuting. Pietrucha reports that the number of telecommuters increased from four million in 1990 to eleven million in 1997 (Pietrucha, 1997a). If numbers included after-hours telecommuting, numbers could be even higher. In 1996, an International Data Corporation survey found that while only six to nine million people were considered telecommuters, an additional eleven million people spent several hours a week doing after-hours telecommuting at home. Several trends in society account for these increases in telecommuting. Some notable trends include an increase in the amount of time that different Americans are working and the

times when they are working, the continuing decrease in the price of equipment necessary for typical telecommuting, and increasing pressure on companies due to legal issues.

Changes in Work/Family Environments. According to the U.S. Department of Labor (US Department of Labor Bureau of Labor Statistics, 1997a; 1997b), both the length of the workweek and the total number of hours worked in a year has been increasing. The share of people working very long workweeks (49 hours or more) has increased, while the number working 40 hour weeks has declined. From 1976 to 1993, men added 100 hours to their yearly total of hours worked, while women added 233 hours. This increase in hours worked puts an increasing strain on the amount of time that people can spend with their families. Many people who telecommute cite this ability to do home chores/child care as a major factor in their decision to telecommute (Work Remote and Otherwise and Family: Shifting the Balance, 1995). Additionally, many telecommuters work during non-typical work-hours, squeezing in a few hours of work after dinner or working in the wee hours of the morning (Liebmann, 1996).

Lower Cost and Increased Availability of Technology. An additional trend that impacts the increase in the number of telecommuters is the increasing availability of low-priced computer and telecommunications technology. According to Reuters (1997), 43% of all households had a personal computer in 1997, up from 35% in 1996, with the advent of personal computers costing under \$1000 driving the strength of the market. The easy access to voice mail, computer technology, and the internet are also cited as major drivers for telecommuting (Eismann, 1995). According to Pietrucha (1997b), 75% of telecommuters have personal computers, and 31 % of them use the Internet.

Legislation. Environmental, disability-related, and family-related legislation has also substantially contributed to the increase in the number of telecommuters. According to Hamilton (1996), compliance with the Clean Air Act was cited as the most significant driver of telecommuting. The Clean Air Act attempts to reduce “greenhouse gas” emissions, and the congestion that contributes to it, by decreasing the number of single driver cars that commute in a given day. According to Tucker’s research, telecommuting can help employers meet the requirement that the average number of riders per car in non-attainment areas be increased by 25% (1993).

The Americans with Disabilities Act (ADA) is another key piece of legislation that drives telecommuting. The ADA mandates that employers with 15 or more employees make reasonable accommodations for people with disabilities. According to Durkin (1997), telecommuting has become a popular reasonable accommodation. At the extremes, cases of “reasonable accommodation” involving telecommuting have gone to court. In June 1997, Michael Faircloth, a disabled worker with a back injury sued the San Francisco Bay Area Transit District for failing to provide him with the ability to telecommute as a reasonable accommodation (Durkin, 1997). He won his case and was awarded \$90,000. In a related case, Alma Hernandez sued the city of Hartford Connecticut for failure to allow her to telecommute due to problems with pre-term labor. The court found that telecommuting would have been a reasonable accommodation and determined that Hernandez may bring an employment discrimination claim against the city (Telecommuting as a “Reasonable Accommodation”, 1997).

Additional legislative acts have an impact on telecommuting. The Federal Climate Change Action Plan contains provisions that would pay employers equivalent

value of parking tax exemptions for parking spaces eliminated through telecommuting (White House Conference Highlights Clean-air Issues, 1994). Compliance may also be achieved with the Family Leave Act because telecommuting allows flexibility in arranging care for children and the elderly (Tucker, 1993). Other state and local rules may also drive telecommuting (Durkin, 1997).

Advantages and Disadvantages for the Air Force

As the Air Force evaluates a proposed methodology for implementing a telecommuting plan, it must consider both the needs of the Air Force and the needs of Air Force Personnel. This section reviews advantages and disadvantages of telecommuting for the Air Force.

There are many advantages and disadvantages to be evaluated on behalf of the Air Force when considering the implementation of a telecommuting program. Obviously, first and foremost, a program that implements telecommuting within the bounds of the President's Management Council's definition will serve as an immediate response to the President's tasking. Determining which specific program to implement should be accomplished by evaluating the cost and performance tradeoffs associated with each level of telecommuting implemented. Some of the common relevant advantages and disadvantages are illustrated in Table 1-1, an adaptation of a table presented by Staneck (1993).

Table 1-1. Advantages and Disadvantages of Telecommuting for the Air Force

Advantages	<ul style="list-style-type: none">- improved quality of work output- increased productivity- reduced overhead- reduced absenteeism and sick leave- improved employee recruiting and retention- improved ease of handling for schedule fluctuations- improved ease of handling for emergency situations- reduced real-estate costs
Disadvantages	<ul style="list-style-type: none">- difficulty in overcoming organizational-level institutional barriers- difficulty of remote supervision- security issues- start-up and operation costs- health and safety issues- potential union opposition

Improved quality of work output and increased productivity go hand-in-hand because telecommuters generally achieve these advantages by working in an uninterrupted environment for the same or longer hours than they would at the normal workplace. Increased productivity has been evaluated in several studies that dealt with both full time telecommuting and after-hours telecommuting. All studies found productivity increased when telecommuting was implemented (Duxbury, Higgins, & Mills, 1994; Hughson & Goodman, 1986; Deming, 1994; Venkatesh & Vitalari, 1992; Ruppel, 1992). According to research conducted by the Institute for the Study of Distributed Work, telecommuters boost their productivity by 16% within six months and companies make two dollars in productivity gains for each dollar spent on telecommuting. Productivity gains from telecommuting may come at a price to the telecommuter. Based on the results of several surveys, computer owners increase productivity by working additional hours for no additional pay (Vitalari & Venkatesh, 1992; Duxbury, Higgins, & Mills, 1992; Deming, 1994; Hughson & Goodman, 1986).

Reduced overhead and reduced real-estate costs are achieved by dedicating less space to telecommuters. The assumption behind these savings is that telecommuters require less space since they spend significantly less or no time at all in the office. This applies to parking space as well as office space. According to a Telecommute America study, as many as 92% of managers at companies that allow telecommuting cite cost savings as a major motivator. Additional cost savings will be achieved if the Federal Climate Change Action Plan provisions are enacted into law. They would pay employers equivalent value of parking tax exemptions for parking spaces eliminated through telecommuting (White House Conference Highlights Clean-air Issues, 1994).

Reduced absenteeism and sick leave are another commonly cited advantage of telecommuting. The rationale for these reductions is that employees may work at home when they are not in a condition to work at the office. This also applies to the care of family members which would be covered under the Family and Medical Leave Act of 1993 (U.S. Department of Labor, 1998). When care can be provided by merely being in the same house and checking in periodically, telecommuters can successfully work and provide care to sick family members, rather than taking leave. The advantages citing improved ease of handling for schedule fluctuations and improved ease of handling for emergency situations can also be addressed by this aspect of telecommuting.

Additional advantages include increased morale, decreased absenteeism, and improved employee retention and recruiting (Ruppel, 1996). In support of these advantages, a study conducted by the Institute for the Study of Distributed Work found that the majority of telecommuters surveyed reported increased job satisfaction.

Several commonly cited disadvantages of telecommuting deal with the lack of control an employer has over an employee when the employee is working at home. These disadvantages include the disadvantages of difficulty in overcoming organizational-level institutional barriers, difficulty of remote supervision, health and safety issues, and security issues (Liebmann, 1996; Gold, 1996). While the Air Force, organizationally, may show many benefits by implementing telecommuting, the issue of how to effectively manage a telecommuter is central to the success of telecommuting (Mokhtarian, 1991). The exact implementation of a management policy is problematic since there is no consensus among existing organizations about how telecommuters are to be managed. In fact, Ruppel's research shows that over 80% of existing telecommuting arrangements are on an ad-hoc, informal basis (Ruppel, 1996).

Two final notable disadvantages include the cost of start-up and operations and potential union opposition. Depending on the level of technology necessary to do the job, the cost of start-up and operations varies dramatically. When work can be done through use of a standard computer system and a telephone, start-up costs will usually range between \$1000-\$4000 (Reuters, 1997), and the cost of an additional telephone line coupled with the cost of office supplies will be the limit on the cost of operations. However, as the level of technology required increases, so does the cost of set-up and operations. For example, if a high powered workstation is required with a communications bandwidth in excess of 28.8 kilobytes per second, then the costs of the initial system will double or triple, while operating costs will at least double.

Union opposition may come about based on any number of factors. In one scenario, the union may feel that employees who are allowed to telecommute are being

encouraged to work unpaid overtime. Conversely, if only employees who provide their own equipment and have homes large enough for a personal office are allowed to telecommute, then this becomes a case of a “legally actionable economic discrimination” (Durkin, 1997).

The level of different advantages and disadvantages of telecommuting felt by the Air Force will vary based on the structure of the telecommuting program. Some of the benefits of telecommuting will apply across all levels of telecommuting, while some may only accrue significantly for telecommuting programs that require telecommuters to telecommute one or more full days per week.

Advantages and Disadvantages for Air Force Personnel

For a telecommuting program to be successful, it must be set up in such a way that employees can and will telecommute. The basis for a telecommuting program proposed by the President is its “family friendliness” (President’s Management Council, 1996); however, there are many other personal advantages to telecommuting, along with many personal disadvantages. Table 1-2 below gives a summary of common personal advantages and disadvantages of telecommuting.

Table 1-2. Advantages and Disadvantages of Telecommuting for Air Force Personnel

Advantages	<ul style="list-style-type: none"> - decreased commuting time, work expenses, and stress - increased scheduling flexibility - improved work environment - greater job responsibility and autonomy - performance evaluation based on results - employment opportunity for mobility-impaired - stronger family ties
Disadvantages	<ul style="list-style-type: none"> - professional and social isolation - detrimental to career advancement - may affect performance appraisal negatively - loss of support services - may cause overworking - removal of work/life boundaries - forced subcontracting - may lead to loss of benefits - household conflicts

Many of the advantages of telecommuting relate to the simple mechanics of not making the commute to the office. New York Telephone found that the average telecommuter traveled 189 fewer miles per month. The stress of daily commutes, the cost of maintenance and gasoline for an automobile, along with the time that would have been wasted driving to work all accrue simply by not driving to the office (Ruppel, 1996).

Additional advantages are inherent in the home office environment. Existing telecommuters claim that working at home allows them to avoid interruptions, work at their own pace, avoid purchasing expensive clothing, and to increase their productivity (Venkatesh & Vitalari, 1992; Tucker, 1993). Personal independence is also enhanced since telecommuters are not under direct management supervision and need only be

productive, rather than look productive. This allows for increased scheduling flexibility, where work, family, and social needs can be freely inter-scheduled for an optimal mix. The stress normally associated with dealing with people in an office environment can also be significantly alleviated through telecommuting (Eisman, 1995, Tucker, 1993).

For the mobility-impaired, telecommuting offers the ability for part-time or full-time alternate work accommodations. Workers who become injured, either temporarily or permanently may be allowed to telecommute rather than being forced to lose their job (Mokhtarian, 94). Parents may also find that telecommuting is a preferable alternative to taking family leave or maternity leave.

The majority of disadvantages cited for telecommuters generally refer to loss of contact with the traditional workplace (Ruppel, 1996). Several surveys have found that full-time telecommuters experienced isolation and reduced management expectation (Mazzi, 1996; Eisman, 1995). Chadwick (1996) found that nearly 20% of workers believed that telecommuting would make them invisible to management for promotions and raises. A survey of Booze-Allen-Hamilton workers also found that many potential telecommuters fear that their supervisors may be unable to fairly evaluate their performance based on results alone (Hamilton, 1996). Other disadvantages include the loss of feedback from customers, management, and co-workers, missed training, and loss of mentoring and socialization (Work Remote and Otherwise and Family: Shifting the Balance, 1995).

Other disadvantages from telecommuting generally relate to the family. Duxbury, Higgins, and Mills (1992) found that workers that performed after-hours telecommuting experienced more work overload and role overload. In general, they found that the

presence of a computer in the home is associated with the tendency to overwork and that this overwork comes at the expense of personal time. Additionally, men who participate in after-hours telecommuting do less childcare than those who don't participate.

Goodman and Hughson (1996) identify additional concerns that home office space may infringe on family space, and children's play may be curtailed if it is distracting to the telecommuter.

Thesis Purpose

This thesis will gather information about Air Force telecommuting candidates, in order to assist AF/DP in determining what telecommuting guidance should be given to Air Force supervisors. The proposed research will address major factors in terms of attitudes toward telecommuting, demographics, and an assessment of the importance of different telecommuting issues to Air Force personnel. The results of this investigation should determine the important aspects the Air Force should consider in developing its telecommuting program (including not developing a program at all).

For the purpose of this study, the research question is "What factors should the Air Force consider when developing guidance for supervisors to use when implementing telecommuting arrangements?" The study will use a stated preference model to construct a survey. The survey will be distributed to a random sample of Air Force officer, enlisted, and civilian personnel. Based on analysis of survey results, important factors in telecommuting preference will be identified.

2. Overview of Existing Research and Literature

Introduction

Chapter 1 presented an overview of telecommuting definitions, aims, and some potential advantages and disadvantages. This chapter will explore theories and empirical research that address these issues. The intent of this examination is to build a foundation for decisions to be made about the form of the Air Force's telecommuting program. The first part of the chapter will discuss common issues involved in telecommuting – to include empirical and theoretical evaluation of different advantages and disadvantages of telecommuting. The final part of the chapter will delve into telecommuting decision theory. Telecommuting decision theory deals with the factors that make individuals choose to telecommute. It is the basis for the methodology used in the study, as described in Chapter 3.

To show the academic research relating to the advantages and disadvantages of telecommuting, Tables 2-1 and 2-2 are presented. The comprehensive list of advantages and disadvantages presented in Table 1-1 and Table 1-2 have been updated so that advantages and disadvantages based on formal theories or empirical research are denoted by asterisks. This section will cover theory and empirical research associated with the advantages and disadvantages of telecommuting, along with other findings related to telecommuting.

Table 2-1. Academic Support for Purported Advantages and Disadvantages of Telecommuting for the Organization

Advantages	<ul style="list-style-type: none"> - Improved quality of work output * Increased productivity * Reduced overhead - Reduced absenteeism and sick leave * Improved employee recruiting and retention - Improved ease of handling for schedule fluctuations - Improved ease of handling for emergency situations - Reduced real-estate costs
Disadvantages	<ul style="list-style-type: none"> * Difficulty in overcoming organizational-level institutional barriers * Difficulty of remote supervision - Security issues * Start-up and operation costs - Health and safety issues - Potential union opposition

Table 2-2. Academic Support for Purported Advantages and Disadvantages of Telecommuting for Individuals

Advantages	<ul style="list-style-type: none"> * Decreased commuting time, work expenses, and stress - Increased scheduling flexibility - Improved work environment - Greater job responsibility and autonomy * Performance evaluation based on results - Employment opportunity for mobility-impaired * Stronger family ties
Disadvantages	<ul style="list-style-type: none"> * Professional and social isolation * Detrimental to career advancement * May affect performance appraisal negatively - Loss of support services * May cause overworking * Removal of work/life boundaries - Forced subcontracting - May lead to loss of benefits * Household conflicts

Because many of the advantages and disadvantages of telecommuting overlap for both organizations and individuals, the topics are grouped by topic rather than with relation to individuals or organizations.

Productivity

Productivity studies have focused on a variety of different areas and have produced findings that include both positive and negative results. In Massachusetts' telecommuting pilot study (1996), 83-87% of all telecommuters reported increased productivity, while between 97-100% of their supervisors reported that productivity had increased. Hughson and Goodman (1986) surveyed forty-eight of the fifty largest employers in Pittsburgh, PA. They found that productivity increased with telecommuting as a function of output per dollar. However, they caution that productivity gains were produced by a combination of effects that included more hours worked for the same pay, more efficient use of time because of fewer distractions, and increased use of computer versus manual methods. Duxbury, Higgins, and Mills (1992) reported similar results in their study of work-family conflict. Their findings indicate that implementation of telecommuting leads to a direct increase in the total hours worked by telecommuters. Telecommuters surveyed by Mazzi (1996) report that work at home is more efficient than working in the office and is best suited for high-concentration, individualized tasks. In a study that addressed supplemental work at home (after-hours telecommuting), Venkatesh and Vitalari (1992) found that respondents undertook work at home to increase productivity, work at their own pace, and avoid interruptions.

The Department of Energy's (1994) report on telecommuting found telecommuter's productivity increased on telecommuting days. However, coworkers'

productivity may not have improved. This raised questions about the productivity of the overall workgroups. The study raised questions about overall workgroup productivity because there may have been a need for remaining workers to pick up the slack left by telecommuters. Survey results indicated that workgroup productivity was variably affected by telecommuting (Department of Energy, 1994). Christensen (1988) found that productivity and telecommuting hours were negatively related. This indicated that additional telecommuting does not necessarily increase productivity. Christensen also notes that government employees report higher productivity than private employees and that productivity varied depending on who initiated the telecommuting arrangement (employee, employer, mutual). Employee initiated telecommuting resulted in the lowest levels of productivity.

Effects of Telecommuting on Supervisory Relations

Lack of management support is a frequently cited reason for failure of telecommuting programs (Rotter, 1996). Managerial resistance is often attributed to an inability to visually observe the behavior of employees. Managers accumulate information about employees passively. They are often unaware that they are monitoring the employee for evaluation purposes. Typical evaluation techniques include scanning for employee presence and noting when employee behavior has changed from expected behavior. Telecommuting may deprive managers of these primary pieces of evaluative information.

Direct observation is rare in most organizations (Rotter, 1996). Factors like the demands on supervisors' time and the unobservable mental processes involved in many tasks make observation difficult or impossible in many instances. When direct

observation actually occurs, it can distort the information obtained. When employees are aware of being observed, their performance may shift from what is normal to what is maximal (Rotter, 1996).

Much of the information gathered by supervisors on subordinates comes from indirect sources (Rotter 1996). Managers hear complaints and praise regarding employees, read documents and make inferences about employees based on quality and timeliness of work delivered and so forth. In studies conducted on the accuracy of rating techniques, indirect observations resulted in greater appraisal accuracy than direct observations. However, managers generally prefer to use direct methods of information gathering (Rotter, 1996).

Gray, Markus, and Westfall (1996) attempted to explain management lack of support for telecommuting by invoking "Agency Theory (Eisenhardt, 1989)" and "Institutional Theory (DiMaggio and Powell, 1991)." Agency theory deals with the social contract between employees and employers. Based on agency theory, Gray et al. derive five propositions that relate to telecommuting. The first proposition was, "if the employer can verify what the telecommuter is doing, the telecommuter is more likely to behave in the employer's interest (p.25)." In other words, managers feel that they must see employees to supervise them. They fear that, if they cannot observe the employee's behavior, the employee will be tempted to shirk. Unfortunately, direct observation of workers tends to measure activity rather than the quality of output.

Agency theory's second proposition is, "the goals of the employer and the telecommuter will be closer to one another if the telecommuter is judged on the basis of outcome rather than on the basis of behavior (p.25)." The link between employer goals

and telecommuter goals are postulated to contain high amounts of goal conflict. The proposition states that an outcome-based contract can be used to achieve goal congruence between the telecommuter and the telecommuter's employer. This would lead to performance based evaluation of telecommuters as opposed to activity based evaluation.

The third agency theory proposition is "if telecommuters perform programmable tasks, their work can be behavior based (p.25)." This proposition says basically that if tasks are broken down into simple, well understood portions, then managers are better able to assign them to telecommuters and to monitor their performance.

The fourth proposition is: "it is harder to measure telecommuting outcomes if the telecommuter is judged on the basis of behavior than on the basis of outcome (p.26)." This proposition deals with the types of outcomes from jobs. For example, sales or piece work contracts can be easily quantified while jobs such as staff analysts or public relations people are much more ambiguous and difficult to measure.

The final proposition is, "the longer a person has worked for a company, the more likely they are to be allowed to telecommute (p.26)." Over time, the amount of trust and knowledge between parties is expected to increase, thus decreasing the need for supervision. This proposition would justify limiting telecommuting to people that have been with an organization for a long time.

As a conclusion to the authors' examination of Agency Theory, Gray et al. (1996) believe that telecommuting tends to shift worker evaluations from a behavior to an outcome basis, which is undesirable for all parties. The change is undesirable because, for managers, outcomes are more difficult to measure than activity, and, for employees, outcome-related risks must be assumed by the employee, who is generally risk averse.

Institutional theory (Gray et al., 1996) holds that organizations avoid evaluating their goal achievement activities because evaluation raises questions about the legitimacy of these activities. Institutions concentrate instead on conformity to established norms and participation in ritual activities. The tendency to follow these practices is so strong that they may persist even though they are in conflict with more efficient ways of performing tasks. Therefore, the lack of institutional support for telecommuting is consistent with its relatively low usage despite its well-documented benefits.

Based on institutional theory, Gray et al. offer the following set of hypotheses for testing:

1. Traditional office workers prefer not to telecommute because it brings the legitimacy of their actions into question (p. 28).
2. Part-time and temporary workers are more willing to telecommute because there are less challenges to the legitimacy of their work (p.28).
3. Organizational demand for telecommuting will remain low unless there is a very high cost/benefit ratio or a compelling need for telecommuting (p.28).
4. The older the organization, the more institutionalized it becomes, and therefore, the less likely it is to adopt telecommuting (p.28).
5. The success of telecommuting will be greater where remote work is already institutionalized (p.28).

Gray et al. (1996) also draw conclusions from institutional theory. These conclusions include the concept that interventions designed to increase the use of telecommuting will be more successful if they are aimed at industry-level practices rather than individual organizations or managements. Incentives at the societal level (e.g.

individual tax deductions) are more likely to increase telecommuting among entrepreneurs and contractors than among traditional organizational employees. Technologies such as video conferencing have the potential to mitigate problems of telecommuting legitimacy by transferring aspects of the traditional office to remote workers. Finally, providing training from institutionally-sanctioned sources and implementing facilities designed to increase interaction with remote workers will increase the institutional legitimacy of telecommuting.

Hartman, Stoner, and Arora (1991) found that telecommuters' satisfaction with the performance evaluation system's capacity for evaluating work done-at-home correlated with self-reported telecommuting productivity and satisfaction. The correlation between evaluation of work and productivity was 0.26 ($p < .05$), and the correlation between performance evaluation and telecommuting satisfaction was 0.35 ($p < .01$).

The Massachusetts Telecommuting initiative (1996) did not find that management impeded telecommuting programs. In this survey, managers did not generally agree that telecommuters required more frequent interaction or needed to be closely monitored. Supervisor surveys also cited improved employee attraction and retention as a benefit of telecommuting.

Work-Family Interactions in Full-time Telecommuting

While telecommuting is often offered to allow employees to better support their families, there may be positive and negative effects that occur when employees take work home. The Massachusetts Telecommuting Initiative (1996) found that telecommuters cited more time to spend with families as an advantage of telecommuting. Most telecommuters (87%) reported telecommuting had a positive impact on their home life.

About 88% of the respondents indicated that telecommuting improved their ability to meet household needs. Other significant benefits included the ability to run errands (75%) and reductions in the stress of commuting (84%). Capelli (1995) found that some survey respondents believed that telecommuting was allowing them flexibility in family life and involvement in taking care of family needs. Parents of preschool-aged children were most favorable in this respect. However, survey respondents did not have an easier time balancing work and family life. Some respondents felt that working at home blurred the boundary between work and family. In Hughson and Goodman's study (1986), respondents felt that telecommuting allowed them to fulfill two roles at once, that of manager and family member. However, respondents did not find that telecommuting increased leisure time. Christensen (1988) found that telecommuting failed to alleviate the need for childcare because it was not possible for women to simultaneously care for children and perform work. Survey results (Hartman et al., 1991) supported the relationship with a correlation between family disruption and telecommuting of $r = -.29$ ($p = .004$). Additionally, the survey revealed that satisfaction with telecommuting tended to decrease as employees' perceived an impact on their ability to be the kind of spouse and parent they would like to be. It also decreased as a function of how preoccupied they felt with work at home.

Work-Family Interactions in Part-time or After-hours Telecommuting

Duxbury, Higgins, and Mills (1992) found that career mothers and fathers who performed after hours telecommuting experienced more role overload and interference with work and family roles than non-telecommuters. Additionally, they noted that men who perform after-hours telecommuting devote significantly fewer hours to childcare

than their counterparts without computers. Venkatesh and Vitalari (1992) found that work at home often came at the expense of leisure and family time.

Impacts of Telecommuting on Leisure Time

Hughson and Goodman (1986) found that, while respondents felt that telecommuting allowed them increased flexibility, they did not find that leisure time increased. Venkatesh and Vitalari (1992) found that after-hours telecommuting time came at the expense of socializing and watching television. They conclude that people who perform work at home generally don't directly substitute work at home for hours at the office. Rather, they supplement office hours with after-hours telecommuting.

Vehicle Pollution, Congestion and Fuel Use

Travel logs from the Massachusetts Telecommuting initiative (1996) indicated that telecommuters drove 31.5 fewer miles on days that they telecommuted. They also averaged 24.5 fewer daily miles than non-telecommuters. Based on these findings, Massachusetts projected that telecommuters drive 3,226 fewer miles per year than non-telecommuters. This reduction in mileage represented a savings of \$194 in gasoline savings per telecommuter per year. The Department of Energy, in its 1994 report on telecommuting, projected a savings of between 17 and 35 billion total driving miles per year as a result of telecommuting. Due to the corresponding savings in highway costs, the DOE projects a cost savings of \$13 billion to \$20 billion by the year 2010. Mannering and Mokhtarian (1995) found that despite the projected advantage of relieving long commutes, length of commute did not predict the frequency of telecommuting.

Cost to Corporations

Supervisors in the Massachusetts Telecommuting Survey (1996) indicated that telecommuting led to happier employees, more productive employees, reduced costs, and improved employee retention and attraction. On the negative side, Rognes (1996) found that telecommuters took advantage of company policies to upgrade their computer systems. The study found that some of the purchased equipment was rarely or never used and that more powerful equipment was procured than the work required. The DoD's Human Computer Interaction Concept Plan (1995) expects to show savings in office space when telecommuting is implemented.

Isolation

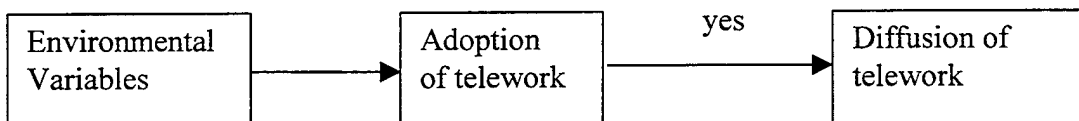
Rognes (1996) cites isolation and lack of disruptions as one of the positive aspects of telecommuting. However, other studies show that continued isolation may have negative impacts on telecommuters. Chadwick (1996) cites survey results that show that 20% of workers believed that telecommuting would make them invisible to management for promotions and raises. Mazzi cites a telecommuting study group where telecommuters who only worked in office groups felt isolation. In contrast, telecommuters who worked both individual projects and office projects were able to avoid isolation almost entirely. Since telecommuters typically work 1.2 days per week (Mazzi, 1996), isolation that would be felt by full-time telecommuters may be avoided. Mazzi cites studies that show that only 22% of telecommuters blamed their telecommuting days for feelings of not belonging to office groups. Fritz, Narasimhan, and Rhee (1996) cite the lack of informal organizational communication as one of the disadvantages of telecommuting. Informal communication refers to unplanned

communication about work-related problems and includes peer discussion and ad hoc, unstructured meetings. Fritz and Narasimhan also cite a loss of informal professional training. Fritz and Narasimhan's study of telecommuters, however, did not reveal a significant difference in satisfaction with informal communication between remote and traditional workers. On the other hand, there was a positive correlation ($r=.232$, $p=.006$) between satisfaction with social opportunities and increased face-to-face communication. Other findings indicate that telephones do not fulfill the need for keeping up with office gossip and politics.

Mazzi (1996) draws on "Social Identity Theory" to explain why people who conform with group identities will be favored over those with strong personal identities. Social Identity Theory suggests that group identities compete with external individual identities and evaluate external individuals' contributions to the group more critically than those of internal group members. Chadwick (1996) contends that isolation may be alleviated by using "rich" media such as e-mail or video conferencing to replace social contacts lost due to telecommuting. Survey results suggested that telecommuters may also reduce isolation by joining professional organizations, having lunch with colleagues, using e-mail, or working in telecommuting centers. Fritz et al.'s (1996) results seem to agree with Chadwick's (1996). They showed a positive correlation between e-mail usage and satisfaction with the ability to get help from colleagues.

Other Issues Relating to Telecommuting

Organizational Adoption of Telecommuting. Ruppel (1996) performed a study to model external environmental factors that lead to the adoption and diffusion of telecommuting. From an organizational perspective, Ruppel investigated seven factors that may have a significant effect on the adoption of telecommuting by organizations. These factors are as follows: 1) perceived competitiveness of the marketplace, 2) implementation of telework by perceived competitors, 3) perceived globalization of the marketplace, 4) communication with external consultants, 5) the existence of regulatory legislation, 6) perceived shortage of external labor supply, and 7) perceived sensitivity to concerns about the ecological environment. Using these factors, Ruppel developed a model of telecommuting that shows the relationship between environmental factors and the actual diffusion of telecommuting (shown in Figure 2-1)



Ruppel, C. The effect on environmental factors on the adoption and diffusion of telework. Proceedings from the '96 Telecommuting Conference. University of Georgia, 1996.

Figure 2-1. Organizational Environment System

Ruppel's study reflected the perceptions of 252 top information systems (IS) executives. Factors that were predictors of adoption of telework included competitive markets, competitors having implemented telecommuting, globalization, and legislation encouraging telecommuting. Survey results indicated that 15% of IS staff telecommute the equivalent of 1 to 5 days per week. It should be noted that none of the factors that led

to the adoption of telework showed a significant correlation with the diffusion of telework.

Hughson and Goodman's survey (1986) found full-time and part-time telecommuting is uncommon. However, after-hours telecommuting is fairly common (in excess of 50% of the sample). Telecommuting arrangements were typically informal.

Deming (1994) reports that the majority of people who work at home are doing so without formal arrangements or remuneration. Mokhtarian (1995) estimates that between .75 and 1.33% of workers nationwide are telecommuting on any given weekday.

Mokhtarian (1995) speculates that land use policies may inhibit telecommuting. In some areas, zoning laws do not allow residents to work at home. In 1985, for example, Chicago prohibited working at home if it involved electronic equipment. Los Angeles, a city noted for congestion and pollution, prohibits home-based businesses but does allow telecommuting.

Appropriate Work. Rognes (1996) found that telecommuters expect to do mainly individual work tasks at home. These tasks include reading, writing, and planning. Mazzi (1996) found that telecommuters save individual tasks for telecommuting days and are therefore free to work exclusively on group projects on non-telecommuting days. Rognes also cites a study that found that telecommuters used telecommuting days to do work that they believed would be interrupted at the office. Venkatesh and Vitalari (1992) found that managerial and professional occupations are the primary users of after-hours telecommuting. They believe this is true because these occupations are characterized by significant autonomy, control over schedules, and easily transportable work tasks.

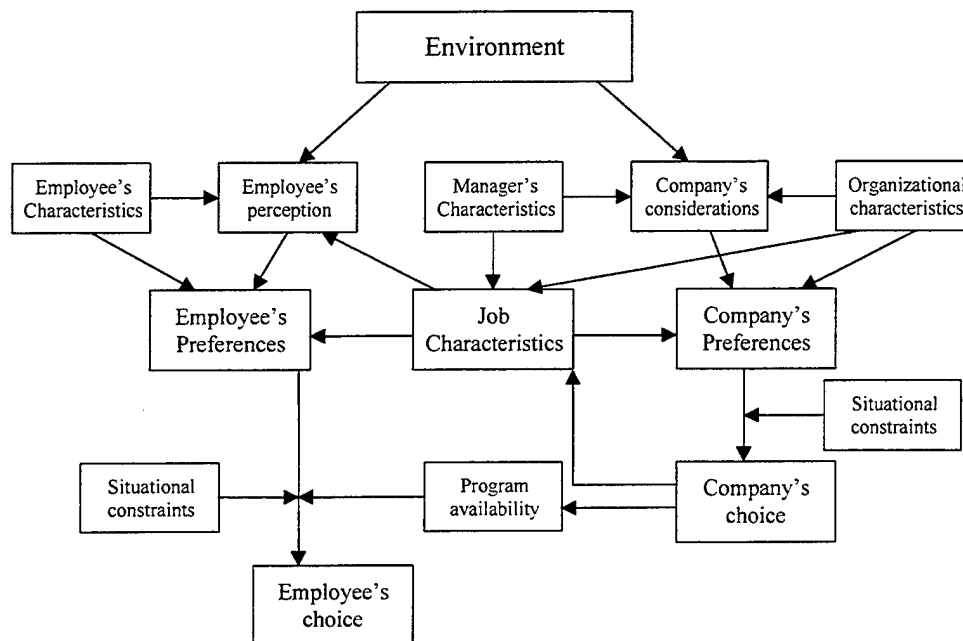
Telecenters. Telecommuting centers are receiving increased attention as an alternative to home-based telecommuting. Stanek (1993) surveyed a group of prospective telecenter users, home-based telecommuters, and non-telecommuters in order to determine the differences between the groups. Significant findings involving differences between home-based telecommuting and center-based telecommuting included the following. Potential telecommuters believed that their supervisors were more willing to let them work from a telecommuting center than from home. Respondents who reported high levels of frustration with their jobs were more likely to prefer telecommuting from home. Respondents who worked larger amounts of overtime preferred working from a telecommuting center. The presence of young children at home also drove respondents to prefer working from a telecommuting center. Older respondents also preferred working from a telecommuting center. However, as a final note, the majority of Stanek's sample did not have an exclusive preference for one form of telecommuting over another.

The Government Services Agency (GSA) telecommuting homepage (<http://www.gsa.gov/pbs/owi/overview.htm>) discusses the success of telecommuting centers in government experience. According to the GSA, approximately 10% of federal telecommuters participate in center-based programs. However, in experiments run by federal and state governments, telecommuting centers have been unsuccessful. According to the GSA, no telecommuting center projects have achieved financial success. Once the initial subsidy has been exhausted, participation drops off. Centers typically close or have been subsidized by local governments to allow continued operation.

Stated Preference Models of Telecommuting

In order to predict use of telecommuting programs and allow emphasis on factors important to potential telecommuters, significant effort has gone into developing “stated preference” models of telecommuting. Different researchers have attempted to develop models which will show the factors having a significant role in determining an individual’s preference for telecommuting. Typical model factors include productivity, family, environmental concerns, and time and cost savings. Unfortunately, no time series studies have been performed to determine whether personal preferences translate into telecommuting program participation. Stated preference models have typically been developed by surveying a group of potential telecommuters and linking survey responses to a binary decision to telecommute or not telecommute. This section will give an overview of several different stated preference models. The last of these, a model developed by Mokhtarian and Salomon (1995) serves as the conceptual basis for the current study.

Sullivan, Mahmassani, and Yen (1993) developed a telecommuting model that includes aspects of employee organizations, employee managers, environmental factors, job characteristics, and individual employee factors. The model is reproduced as Figure 2-2.



Mahmassani, H.S., Yen, J., Herman, R., & Sullivan, M.A. "Employee Attitudes and Stated Preferences Toward Telecommuting: An Exploratory Analysis," *Transportation Research Record* 1413, 1993:31-41.

Figure 2-2. Telecommuting Adoption Process

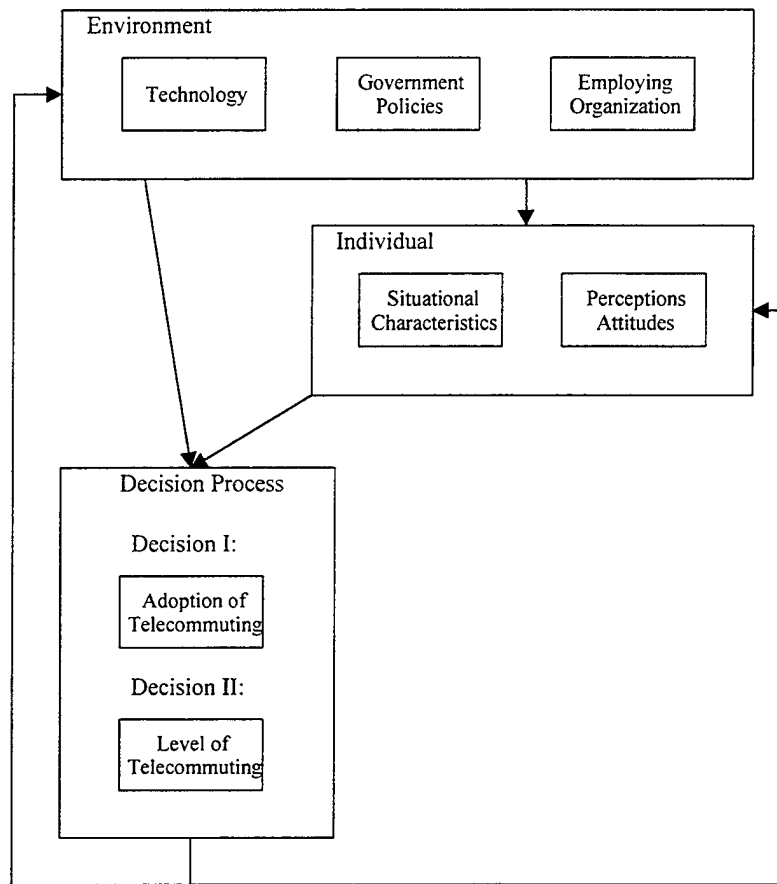
Mahmassani et. al. (1993) developed a four part survey instrument. A total of 662 respondents returned the survey. Surveys were analyzed using a multinomial logit model. The authors found that a preference for telecommuting correlated with the following factors: longer work commute times, number of stops in the work commute, amount of computer use in respondents' jobs, and gender (i.e. women preferred telecommuting more than men). A negative correlation of $r = -.54$ ($t = -2.10$) was found between the existence of regular face-to-face communication at work and telecommuting preference (Mahmassani et. al., 1993:45).

Other findings from the Mahmassani et al. (1993) study served to highlight common beliefs about telecommuting. Respondents overwhelmingly felt that their

supervisors were not likely to approve of their working at home. They also thought that working at home would decrease their chances for promotion. Respondents that had experience with telecommuting were more likely to believe that their jobs were at least partially suitable for telecommuting. Respondents who already owned a personal computer expressed a stronger preference for telecommuting. In general, employees preferred telecommuting a few days per week over full-time telecommuting. Finally, 90% of respondents with more than two children under 16 expressed a desire to work at home. Only 63% of respondents without children preferred working at home.

Based on the results of their survey, Mahmassani et al. (1993) concluded that implementation of telecommuting programs may require job design. This was because respondents needed to have access to information presently available at the office. The other major recommendation they made was that a fair method of performance evaluation should be implemented. This might offset widespread beliefs that working at home will decrease telecommuters' chances of promotion.

Bernardino, Ben-Akiva, and Salomon (1993) developed a somewhat different framework for modeling telecommuting adoption. Their process focused on two factors affecting the telecommuting decision process—the environment and the individual. Their decision structure is illustrated in Figure 2-3. Major elements of the proposed decision structure are described in the following paragraphs.



Bernardino, A., Ben-Akiva, M., & Salomon, I. "Stated Preference Approach to Modeling the Adoption of Telecommuting," *Transportation Research Record* 1413. 1993:22-30.

Figure 2-3. Framework for Modeling the Telecommuting Adoption Process

In the Bernardino et al. model (1993), environment consists of social, cultural, economic, technological, and institutional factors. Technology may serve as a facilitator or barrier, depending on the technology involved. Government policies serve to encourage adoption of telecommuting. The employing organization makes the decision to make telecommuting available.

Organizational aspects of telecommuting may vary considerably. According to Bernardino et al. (1993), telecommuting occurs when work is performed at a remote location and travel patterns are altered. Telecommuting programs may be formal or informal, and they may be performed at home or at a telecommuting center. Scheduling

may be flexible or inflexible. It may be determined by the organization or by the individual. Employment conditions may also vary. Telecommuters may be treated as employees or as contractors. They may be paid by the task or by the hour. Equipment may be provided by the employee or by the employer. Liability for equipment, information, and health and safety may be determined differently.

Individual characteristics include situational and attitudinal/perceptual factors. Situational factors include job characteristics, commute characteristics, and demographic issues. Job characteristics include the amount of face-to-face interaction required and the type of equipment required. The commute is characterized by the total commute time, level of congestion, and inconvenience. Demographic factors include gender, presence of children or adults with special care needs, household income, and level of education.

To test the model, surveys containing questions relating to the above constructs were distributed to a convenience sample of eight internet USENET groups. Fifty-four individuals answered, of which forty-six were male.

Survey respondents indicated that the main benefits of telecommuting included increased flexibility, increased productivity, and reduced commuting stress. The most relevant barriers were standard office hours and the lower efficiency of telecommunication media compared to face-to-face communication. As predicted by the model, all telecommuting costs borne by the telecommuter had a negative impact on telecommuting preference. Other results included the finding that the telecommuting arrangement proposed significantly impacted the telecommuting preference.

Mokhtarian and Salomon (1994) developed, tested, and refined a stated preference model in an effort to better understand telecommuting adoption in California.

According to Mokhtarian and Salomon (1994), the decision to telecommute can be modeled as the result of two kinds of factors; drives or motivators, which motivate a person to make the decision to telecommute, and constraints or enablers, which allow or prohibit a person from telecommuting. To successfully get a person to telecommute, constraints must be removed and sufficient drives must be in place to make the person prefer telecommuting over normal work at an office.

Mokhtarian and Salomon divide constraints into two groups, internal and external. The following table summarizes their proposed set of constraints. When constraints are removed or altered in favor of telecommuting, they may be characterized as facilitators (as opposed to lack of constraints).

Table 2-3. Constraints and Facilitators for Telecommuting

External	Internal
Awareness-related	Psychosocial
Lack of Awareness	Personal interaction needs
Misunderstanding	Household interaction problems
Organization-related	Lack of discipline
Lack of employer support	Risk aversion
Managerial disapproval	Perceived beneficial commute
Job-related	
Job unsuitability	
Unavailable technology	
High Cost	

According to Mokhtarian and Salomon (1994), there are a number of external constraints. Lack of awareness occurs when an employee is not aware that telecommuting is a work option. The individual cannot take advantage of telecommuting opportunities. Misunderstanding occurs when employees don't believe telecommuting is available in a form that they would want to use, or they believe it isn't available to them

personally. Lack of employer support occurs when the employer implicitly or explicitly disapproves of telecommuting. Managerial disapproval focuses on whether the individual's supervisor approves or disapproves of telecommuting. Mokhtarian and Salomon describe job unsuitability as "probably the most obvious constraint"; if the job is not suitable for work at home (e.g. mechanics, pilots, secretaries) then telecommuting is not an option. Their notion of unavailable technology deals with whether necessary tools can be obtained to do the work at home. High cost describes costs associated with telecommuting that must be borne by the employee. For example, the cost of an additional telephone line, cost of non-reimbursable copies made at reproduction centers, or the cost of setting up/building an office at home are included in this category.

Mokhtarian and Salomon's model also includes a number of internal constraints/facilitators. Personal interaction needs includes the needs and desires of employees for interaction either professionally or socially with certain people at the primary work site. Household interaction problems addresses the extent to which distractions from other household members and conflicts with other household members affect a potential telecommuter. Lack of discipline deals with all types of discipline, including scheduling work, controlling eating (researchers have found that some people quit telecommuting after they gain weight), and even remembering what materials to bring back and forth to the office. Risk aversion addresses the need to be seen and recognized by the individual's personal supervisor (for promotion and recognition's sake). Perceived beneficial commute is the idea that people actually enjoy, or find some kind of utility in, having a commute to work, and they may be reluctant to give it up.

After dealing with constraints, Mokhtarian and Salomon deal with the concept of drives. Drives to telecommute are summarized in the table below.

Table 2-4. Telecommuting Drives

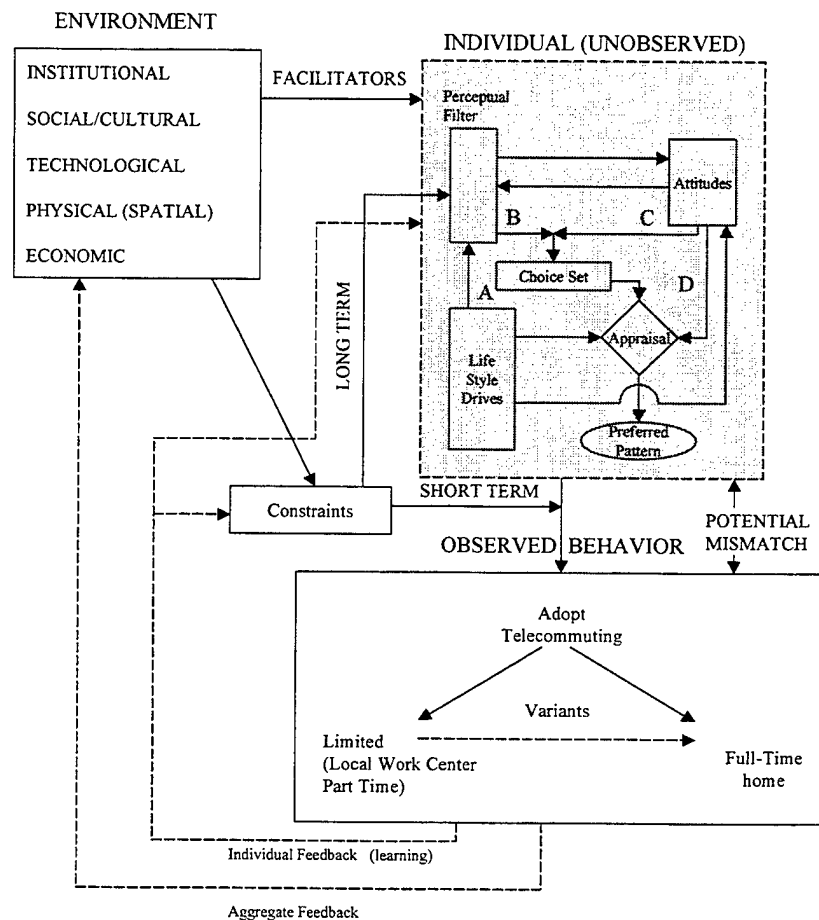
Work-related	Ideology-related
Workplace	Environmental
Independence	Travel-related
Family-related	Commute
Leisure-related	Mobility limitations

Mokhtarian and Salomon (1994) complete their model with a number of different telecommuting drives. Workplace-related drives deal with desires to increase productivity, reduce workplace stress, and to enhance control of the environment. Independence drives are related to personality types; initiative (desire to work unsupervised), entrepreneurship (the desire to be in business for oneself), or antisociability (desire to avoid people) or even misanthropy (active dislike of people). The last two drives only apply to a small set of cases. Family-related drives address the desire to spend time with one's family or the desire for flexibility in arranging dependent care. Leisure-related drives describe the desire to have either more time to one's self or more flexibility in arranging the time a person does have. Ideology-related drives are desires to telecommute to help the environment. Mokhtarian and Salomon do not believe ideology drives are a primary motivator. Travel-related drives are affective reactions to long commutes, burdensome commutes, expensive commutes, and dangerous commutes. Mobility limitations address the desire to be able to work at home in the event of being unable to work at the office due to temporary or permanent disability or parental leave.

Mokhtarian and Salomon suggest that constraints and drives work together to drive the preference to telecommute as shown in Figure 2-3. The individual is affected

by the environment which imposes constraints and facilitators. The individual perceives these environmental inputs through a perceptual filter and builds a cognitive map of the environment.

Based on attitudes and perceived facts, the individual makes a choice to telecommute or not. For an individual to choose to telecommute, there must be a lack of constraints and at least one active drive.



Mokhtarian, P.L., & Salomon, I. "Modeling the Choice of Telecommuting: Setting the Context," *Environment and Planning A*, 26:749-766 (1994)

Figure 2-4. A Schematic Model of the Telecommuting Decision Context

To validate the model, Mokhtarian and Salomon developed a 14-page survey and distributed it to a group of California organizations who were judged to be good

candidates for telecommuting programs. The survey was distributed to 1428 California employees in six agencies. A total of 628 usable surveys were returned and analyzed.

Analysis of the model (Mokhtarian & Salomon, 1994) consisted of a factor analysis to identify redundant variables, followed by a binary logit analysis. From the logit analysis, a model was developed that included nine variables. The variables are presented in Table 2-3.

Table 2-5. Preference Model Estimation Results

Variable	Variable Type	Coefficient	t-statistic
Constant		0.83	1.75
Disability/Parental Leave	Work and Family Drives	0.39	2.02
Stress	Work and Travel Drives	0.74	2.71
Personal Benefits	Independence and Leisure Drives	0.65	2.33
Commute Stress	Travel Drive	0.61	2.58
Commute Time	Travel Drive	0.018	2.29
Amt. Of Tc'ing Job Allows	Job Suitability Facilitator	0.83	5.83
Workplace Interaction	Social/Prof. Interaction Constraint	-0.40	-2.02
HH Distractions a Concern	Household Interaction Constraint	-1.08	-2.62
Commuting Benefit	Benefit of Commute Constraint	-0.43	-2.31
Number of observations	626		
Log-Likelihood at 0	-433.91		
Log-Likelihood at convergence	-137.06		
ρ^2	0.68		
Adjusted ρ^2	0.66		
χ^2	593.7		

In a separate article (Mokhtarian & Salomon, 1996), the authors outlined several additional findings associated with individual items in their surveys. One major finding was that gender was not significant in the model, although several gender-related

variables were. Females expressed higher levels of commute stress and office stress, along with placing higher values on disability/parental leave. One significant finding was that telecommuting was the “preferred impossible alternative” for 50.5% of the respondents, indicating that a simple majority of those sampled desired telecommuting, but felt that they were prevented from participating by external factors. Supervisor reservations were the strongest deterrent to telecommuting. Unexpectedly, manager unwillingness was not strongly ($r=0.21$, $p=.001$) correlated with job unsuitability. Additionally, of those who had the ability to telecommute, only one third actually did (68 of 203). Of all those surveyed, 12% did not want to telecommute.

Differences between those individuals preferring telecommuting and those individuals not preferring telecommuting were also tested using t-tests (Mokhtarian and Salomon, 1996). In terms of commute length, preferrers had a longer average commute than non-preferrers. Preferrers also tended to be younger than non-preferrers. More women preferred to telecommute than men (92% of women vs. 83% of men, $p<.05$). Outside of gender, age, and commute length, no differences were found between sociodemographic and economic groups.

Based on the characteristics of the sample as compared to the general population, the authors concluded that telecommuting is probably possible for no more than one fourth of the workforce at present. Five reasons were commonly cited as explanations for why individuals were not currently telecommuting. They were: (1) lack of resources, (2) never thought about it, (3) not offered or discussed with them, (4) disadvantages outweigh the advantages, and finally (5) would cost too much to telecommute.

Mokhtarian and Mannering (1995) published other significant findings from the survey responses. Significantly, respondents did not perceive a difference between low and moderate frequency telecommuting, indicating the frequencies between one and four days per week may be consolidated into one category. In addition, the following correlations were identified:

- More people in a household correlates with a desire for increased flexibility
- The presence of children under five leads to a preference to telecommute only infrequently
- Individuals who are dissatisfied with productivity levels at the office are more likely to prefer telecommuting
- Respondents who know other people who telecommute are more likely to telecommute themselves
- Respondents who are generally satisfied with life tend to prefer telecommuting.

On a cautionary note, Mokhtarian and Mannering (1995) found that while length of commute is a factor in predicting preference for telecommuting, it is not a good predictor of actual telecommuting behavior. The authors suggest that this may be true because other constraints are in effect. This finding highlights the lack of demonstrated correlation between telecommuting preference and telecommuting behavior.

3. Method

Research Method Selection

The literature reviewed in Chapter 2 was considered a basis for selecting a research method that would best answer questions about key telecommuting aspects for the Air Force. Because the Air Force currently does not have a database of telecommuters that would allow for a review of current telecommuting practices, the stated preference model approach was chosen. Stated preference models created by Sullivan, Mahmassani, and Yen (1993), Bernardino, Ben-Akiva, and Salomon (1993), and Mokhtarian and Salomon (1994) were used as a basis for research instrument development.

Measures

Because several models of telecommuting preference were available, it was decided that it was unnecessary to build an additional preliminary model for the current study. The instrument developed for this study was formed using a three-step process. The first step was to consolidate items from all three stated-preference models. The second step was to eliminate overlaps between the three different instruments. At the completion of the second step, it was found that the Mokhtarian and Salomon (1994) survey encompassed the majority of items from the other instruments. The final step was to filter items included in the final instrument based on the findings of the original study.

Based on Mokhtarian and Salomon's (1994) factor analysis and model analysis, thirteen rating factors were adopted that related to telecommuting advantages and disadvantages. These items were divided into two groups. Using a five-point Likert-type scale, respondents were first asked if they agreed that telecommuting would have the

advantage/disadvantage associated with the factor. Then they were asked to what extent they agreed that the advantage/disadvantage was important. A series of items asked about sex, marital status, number of children, occupation, and military/civilian status. A single item assessed the telecommuting environment, asking "Considering the requirements of your current job, how much do you think the nature of your job would allow you to telecommute?" Response options were: 1. Less than once a month; 2. About 1-3 days a month; 3. 1-2 days a week; 4. 3-4 days a week; 5. 5 days a week; 6. Occasional partial days; 7. Strictly for overtime; and 8. Not at all. Finally, an item asked respondents how often they would like to telecommute (i.e., their "stated preference"). Response options for this item were identical to the telecommuting environment item. The intent of this instrument was to capture at least one item from each of the factors in Mokhtarian and Salomon's model, along with additional items unique to the Air Force's situation.

Individual Instrument Items. Individual items on the survey instrument are described in Table 3-1. The survey was sent out with a scan-tron sheet containing fields for last name, first name, middle initial, date, and identification number. The remainder of the scan-tron sheet contained eighty item-response fields with ten circles each numbered from one to ten.

Criterion Variables. For the stated preference model, the item "How often would you like to telecommute?" was used as the criterion variable. For t-tests, populations were also tested based on the item "How much do you think the nature of your job would allow you to telecommute?"

Predictor Variables. Predictor variables from the survey were used both to create telecommuting models for the overall population, civilian population, military population, officer population, and enlisted population. Predictor variables consisted of items in the survey and dummy variables created from demographic information. Items on the instrument that dealt with the advantages/disadvantages of telecommuting and with the importance of those advantages/disadvantages, along with job characteristics, age, and number of children were used directly as predictors of stated preference. Items indicating military/civilian status and type of occupation were converted to binary dummy variables and included in the models as predictors. Additionally, the military/civilian status and occupational variables were used to perform t-tests on stated preference to determine differences between populations.

Table 3-1. Variable Descriptions

Item Name	Response Range	Response Options
Sex	1,2	Male, Female
Marital Status	1,2	Married, Unmarried
Number of Children 0-5 Years Old	1-4	No Children, 1 Child, 2 Children, More than 2 Children
Number of Children 11-15 Years Old	1-4	Same as Above
Allow Time For Myself	1-5	Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
Reduce the Stress of Commuting	1-5	Same as Above
Allow More Work Done	1-5	Same as Above
Reduce Stress in Main Office	1-5	Same as Above
Easier Dependent Care	1-5	Same as Above
Allow More Independence	1-5	Same as Above
Allow Time With Family	1-5	Same as Above
Allow Control Over Physical Env.	1-5	Same as Above
Can Work With Temporary Disability.	1-5	Same as Above
Can Work With Permanently Disability.	1-5	Same as Above
Reduce or Eliminate Commute Time	1-5	Same as Above
Preference for Work Social Interactions	1-5	Same as Above
Preference for Work Professional Interactions	1-5	Same as Above
Use Commute Time Productively	1-5	Same as Above
Will Increase Family Conflict	1-5	Same as Above
Importance of Reducing Commute Stress	1-5	Same as Above
Importance of Easy Dependent Care	1-5	Same as Above

Table 3-1. (continued)

Importance of More Independence	1-5	Same as Above
Importance of Time With Family	1-5	Same as Above
Importance of Work While Temporarily Disabled	1-5	Same as Above
Importance of Work While Permanently Disabled	1-5	Same as Above
Importance of Work Social Interactions	1-5	Same as Above
Importance of Work Professional Interactions	1-5	Same as Above
Importance of Decreasing Family Conflict	1-5	Same as Above
How Much Will Nature of Job Allow You to TC?	1-8	1. Less than once a month 2. About 1-3 days a month 3. 1-2 days a week 4. 3-4 days a week 5. 5 days a week 6. Occasional partial days 7. Strictly for overtime 8. Not at all
Which of Following Describes Your Occupation?	Dummy Variable for Professional / Technical	Manager/Admin, Professional/Tech, Service/Repair, Clerical/Admn Spt, Production/Construction/ Crafts
Which of The Following Describes Your Occupation?	Dummy Variable for Service/Repair	Same as Above

Procedure

Distribution consisted of 720 surveys sent to twelve separate groups of military respondents and 600 surveys sent to 300 male and 300 female civilian respondents. The military sample was divided into groups representing the following categories: officer vs. enlisted, male vs. female, married vs. unmarried, and married with dependents vs. married without dependents. There was a total of twelve groups. For civilians, the sample was based on 300 randomly selected male respondents and 300 randomly selected female respondents. The final numbers of surveys distributed were based on limitations of the Air Force personnel system and time limitations. Initially, the sampling strategy for this study was driven by the need to obtain a large enough sample ($n > 30$) from each population subgroup to be able to invoke the central limit theorem and use assumptions

of normality in building a model. This was possible for military respondents, but records on civilians did not contain information about marital status or dependents.

Three strategies were considered for distribution of the survey. The methods were web-based distribution, e-mail distribution, and postal/pouch mail distribution (hard copy). Web-based distribution was rejected due to lack of expertise, and reported low response rates (i.e. 30%) (Chief of Staff Survey Shows Jobs, Quality of Life Important, 1998). It might also introduce a sampling bias toward computer users. E-mail distribution was rejected for similar reasons, as well as difficulties with ensuring software compatibility Air Force wide. Postal/pouch mail distribution was selected based on its lack of bias and proven response rate (Hamilton, 1998).

Survey Packet. Instructions to respondents and an operationalized definition of telecommuting were provided in a cover letter included in the packet mailed to respondents. Actual wording is given below:

For the purpose of this survey, telecommuting can be defined as any period of time you take work home from the office to do at home. These options range from taking work home to do after hours or over the weekend, all the way to doing all of your work at home. Please answer the questions based on the type of telecommuting option you would anticipate using. As in any study, the reliability of the findings depends heavily on the cooperation of each person surveyed, so please give your answers some reflection.

Please indicate your answers to the survey questions on the attached scan-tron sheet using a #2 pencil and return it in the enclosed envelope. If you have any questions regarding this survey, please contact Capt Joseph L. Wolfkiel at DSN 785-3375 or commercial (937) 255-3375. We greatly appreciate your cooperation.

The complete package consisted of a question sheet, scan-tron response sheet, cover letter, and return envelope. Packages were mailed via base pouch mail and US Post where appropriate. Full text of the cover letter and the survey instrument are included as Attachments A and B. Respondents were not promised anonymity. However, assurances were given that responses would not be used against them.

Of the 1320 surveys sent, 157 were returned as undeliverable, 7 were unusable as returned, and 449 usable responses were received. This amounted to a 34% return rate for all surveys sent and an effective return rate of 39% for surveys not returned for incorrect addresses.

Sample. Analysis was based on a data set of 449 survey responses. Of these, 240 were women, 209 were men, 204 were civilian, 12 were “other”, 233 were military, of which 130 were officers, and 103 were enlisted. For military groups, response frequencies were between 12 and 27 per group, which was not deemed sufficient to make assumptions of normality. For Civilians, 126 respondents were female and 92 were male.

Analysis

A backward linear regression method was selected for analysis of data. The linear model was chosen for the Air Force rather than binary models used in the stated preference models to date because of the unique requirements of the Air Force program. Whereas other stated preference models had strictly transportation-related goals (typically pollution and traffic congestion reduction), the Air Force program has the option of tailoring its telecommuting structure to achieve any of the possible advantages of telecommuting. Therefore, factors that lead individuals to increase telecommuting behaviors were linked to an eight-level response scale in item 12, which was treated as a linear continuum ranging from no telecommuting at all up to full-time telecommuting and including all levels of telecommuting in between (see table 3-1). The entire population was modeled as a group. Then officer, enlisted, civilian, and military were analyzed as individual populations.

4. Results

In order to derive the most potential use from the data, the analysis was performed in five steps. First, the entire population was combined and analyzed to build a "general telecommuting model" for the Air Force population. Second, consistent with Mokhtarian's (1995:70) finding that populations at different organizations should be modeled differently, the data were broken down into military and civilian samples and analyzed separately. Third, the military data were broken down further into officer and enlisted samples. Fourth, overall, civilian, military, officer, and enlisted samples were compared based on the different items that were significant predictors of telecommuting preference. Finally a series of t-tests was performed to determine if preferences or job characteristics were significantly different for a given occupation or military/non-military status. For each model descriptive statistics, correlation tables, and a description of distribution of telecommuting and job characteristic response frequencies were generated.

Overall Model

Descriptive statistics for the overall model (derived by analyzing the entire sample) are presented in Table 4-1 and Figure 4-1. Telecommuting preference and job environment responses are presented separately due to their relative importance in making decisions about potential reception to telecommuting options. Notably, 86.2% of the sample prefer some type of telecommuting option, while only 78.2% feel their job environment allows it. Alternatively, traditional telecommuting (at least one day per week) is preferred by 57.2% of the sample, while 38.8% felt their job environment would permit it.

Table 4-1. Overall Model Descriptive Statistics

Item	Mean	Std. Dev.
Allow More Work Done	3.58	1.11
Extent of TC Job Allows	4.27	2.20
Allow Time For Myself	3.49	1.20
Importance of Time With Family	3.98	0.95
Reduce Stress in Main Office	3.56	1.15
Number of Children 0-5 Yrs	1.28	0.61
Use Commute Time Productively	2.63	1.14
Can Work While Perm. Disabled	3.58	1.18
Like to Telecommute	5.08	2.20

N=449

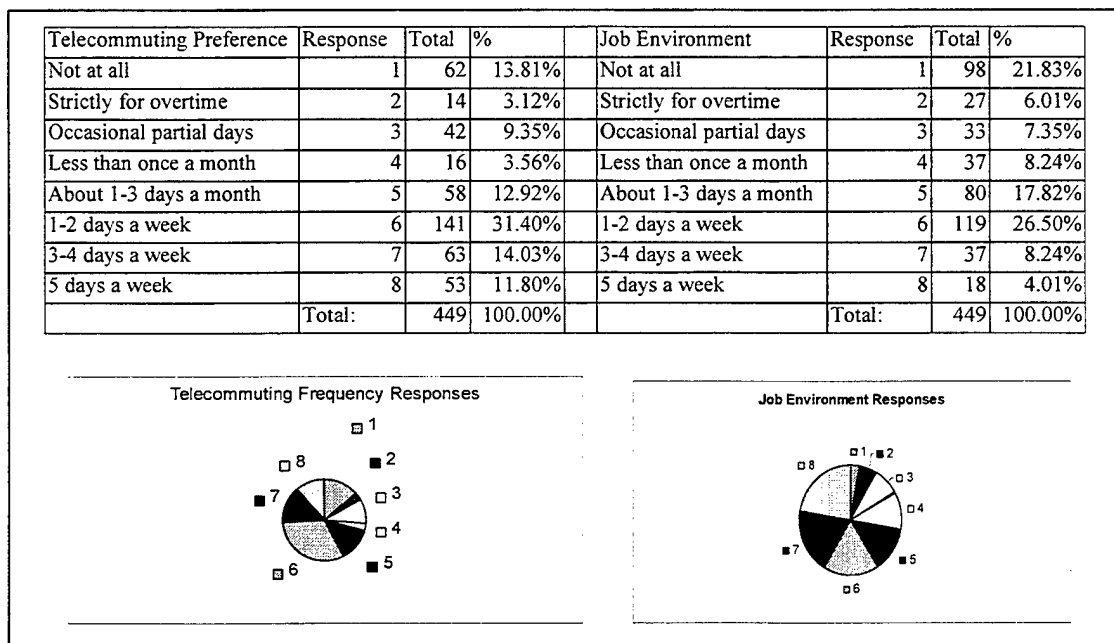


Figure 4-1. Overall Model Telecommuting Preference and Job Environment Response Frequencies

Correlations between items for the overall model are shown in Table 4-2. Only items significant in the overall model were included in the table.

Table 4-2. Pearson's Correlations for Overall Model

INTERCORRELATION MATRIX									
		1.	2.	3.	4.	5.	6.	7.	
1.	Allow More Work Done								
2.	Extent of TC Job Allows	0.39*							
3.	Allow Time For Myself	0.48*	0.24*						
4.	Importance of Time With Family	0.21*	0.16*	0.31*					
5.	Reduce Stress in Main Office	0.55*	0.18*	0.50*	0.28*				
6.	Number of Children 0-5 Yrs	0.02	0.06	-0.03	0.18*	-0.05			
7.	Use Commute Time Productively	-0.22*	-0.07	-0.12*	0.02	-0.17*	0.04		
8.	Can Work While Perm. Disabled	0.37*	0.15*	0.28*	0.20*	0.35*	-0.02	-0.17*	

N=449

*:p<.05

A Summary of the overall model is presented in Table 4-3. The model consisted of eight significant items with p-values of .05 or less. The constant term for the overall model is significant (p=.02) and negative, symbolizing a negative preference for telecommuting before including the items in this model. The analysis of variance (ANOVA) for the model shows that the overall model is statistically significant. The model R-squared was .50. Major factors influencing telecommuting preference included "Allow More Work Done," "Extent of Telecommuting Job Allows," "Allow More Time for Myself," "Importance of Time With Family," "Reduce Stress in Main Office," "Number of Children Zero to Five Years Old," "Productive Use of Commute Time," and "Can Work While Permanently Disabled."

Table 4-3. Overall Regression Analysis Predicting Like To Telecommute

Model Summary							
Variables					Standardized Coefficients		
Model	Entered	R	R Square	Adjusted R Square	Beta	t	p
	Constant: -1.08					-2.33	0.02
1	Allow More Work Done	0.54	0.29	0.29	0.18	3.87	0.00
2	Extent of TC Job Allows	0.64	0.41	0.40	0.35	9.52	0.00
3	Allow Time For Myself	0.67	0.45	0.45	0.18	4.31	0.00

Table 4-3. (continued)

4	Importance of Time With Family	0.69	0.47	0.46	0.10	2.67	0.01
5	Reduce Stress in Main Office	0.69	0.48	0.47	0.12	2.79	0.01
6	Number of Children 0-5 Yrs	0.70	0.49	0.48	0.10	2.90	0.00
7	Use Commute Time Productively	0.71	0.50	0.49	-0.09	-2.52	0.01
8	Can Work While Perm. Disabled	0.71	0.50	0.49	0.08	2.19	0.03

ANOVA

Model	Sum of Squares	Df	Mean Square	F	p
Regression	1091.298	8.000	136.412	55.688	0.000
Residual	1077.816	440.000	2.450		
Total	2169.114	448.000			

Figures 4-2 through 4-4 show the results of common tests of normality. The regression residual plot shows a roughly equal distribution of variance, which suggests that the model has a relatively uniform distribution of variance. The Wilk-Shapiro/Rankit Plot (otherwise known as a Q-Q plot) is roughly linear, which also supports assumptions of normality. Finally, the histogram of residuals shows a roughly normal-looking distribution of residuals around the mean.

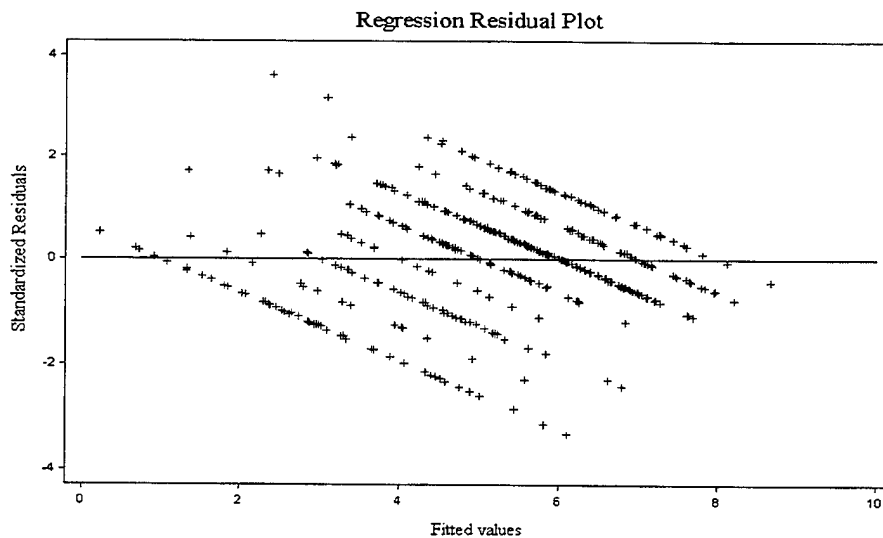


Figure 4-2. Tests of Normality for Overall Model – Residual Plot

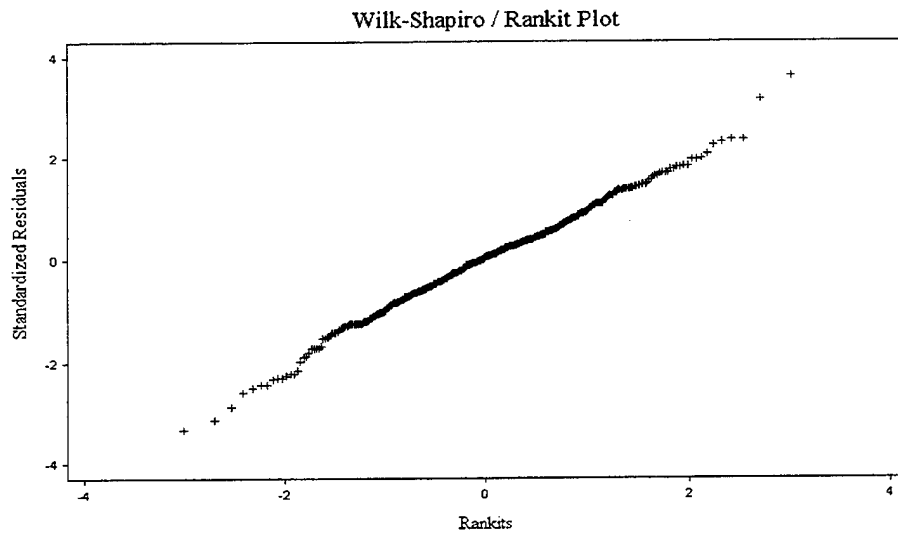


Figure 4-3. Tests of Normality for Overall Model – Q-Q Plot

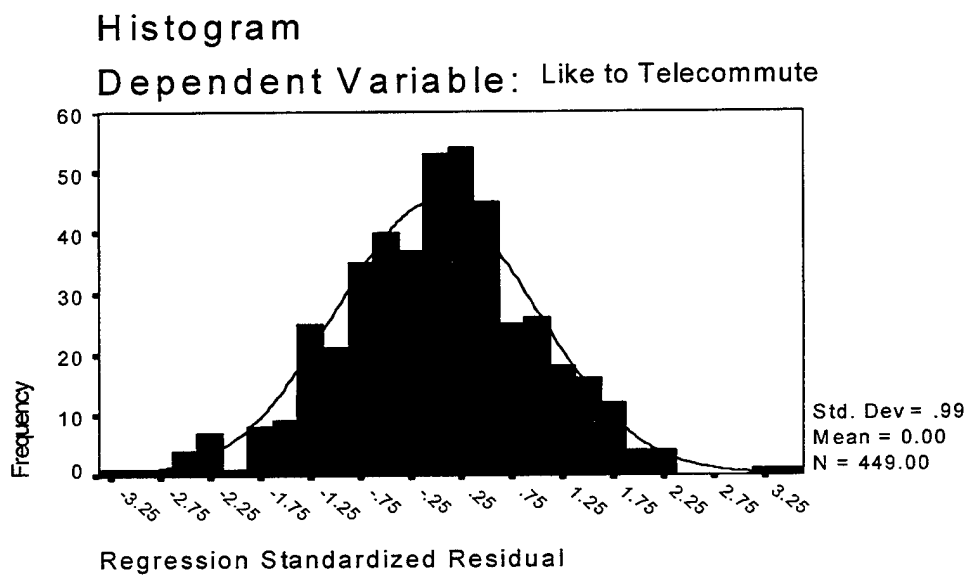


Figure 4-4. Tests of Normality for Overall Model – Regression Residuals

Civilian Model

Descriptive statistics for the civilian model (derived from the 204 civilian responses in the sample) are presented in Table 4-5 and Figure 4-5. Of this sample, 88% preferred to telecommute to some extent, while 74% felt their job environment would allow it. Of the sample, 59.8% of respondents stated a preference for traditional telecommuting, while 41.7% felt the job environment would permit it.

Table 4-4. Civilian Model Descriptive Statistics

Item Name	Mean	Std. Dev.
Allow More Work Done	3.65	1.19
Extent of TC Job Allows	4.20	2.28
Reduce or Eliminate Commute Time	4.13	1.07
Preference for Work Professional Interaction	3.50	0.94
Importance of Time With Family	3.88	0.98
N=204		

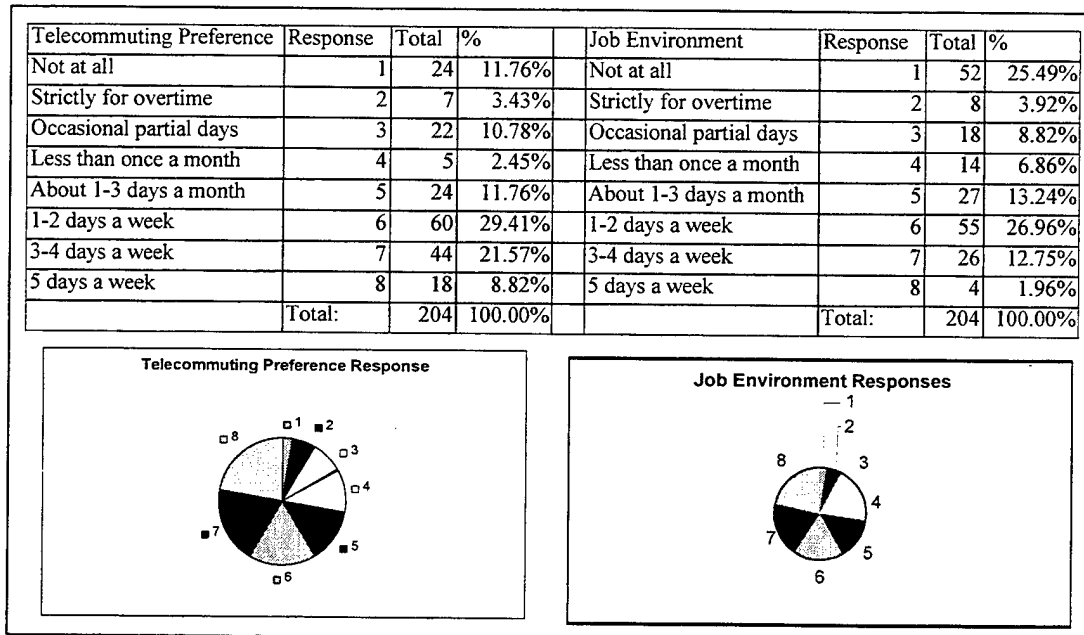


Figure 4-5. Civilian Model Telecommuting Preference and Job Environment Response Frequencies

Correlations between items for the civilian sub-sample are shown in Table 4-5. Only items significant in the model were included in the table.

Table 4-5. Pearson's Correlations for Civilian Model

INTERCORRELATION MATRIX					
		1.	2.	3.	4.
1.	Allow More Work Done				
2.	Extent of TC Job Allows	0.44*			
3.	Reduce or Eliminate Commute Time	0.57*	0.36*		
4.	Preference for Work Professional Interaction	-0.23*	-0.08	-0.18*	
5.	Importance of Time With Family	0.25*	0.11	0.27*	-0.16*

N=204 *.p<.05

A summary of the civilian model is presented in Table 4-6. The model consisted of five items with p-values of .05 or less. The constant term is not significant for this model (p=.197). The model ANOVA shows the model is statistically significant. The model R-squared was .49, which indicates that, given the smaller sample size, this model still contains about the same predictive power as the overall model. This was true although this model features five significant predictors versus the overall model's eight. This model shares three factors with the overall model. These are "Allow More Work Done," "Extent of Telecommuting Job Allows," and "Importance of Time With Family."

Table 4-6. Civilian Regression Analysis Predicting Like to Telecommute

Model Summary							
	Variables				Standardized Coefficients		
Model	Entered	R	R Square	Adjusted R Square	Beta	t	p
1	Allow More Work Done	0.55	0.30	0.29	0.211	3.184	0.002
2	Extent of TC Job Allows	0.64	0.41	0.40	0.346	6.023	0.000
3	Reduce or Eliminate Commute Time	0.67	0.45	0.44	0.209	3.286	0.001
4	Preference for Work Professional Interaction	0.69	0.47	0.46	-0.157	-2.981	0.003

Table 4-6. (continued)

5	Importance of Time With Family	0.70	0.49	0.47	0.110	2.058	0.041
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ANOVA

Model	Sum of Squares	df	Mean Square	F	p
Regression	452.036	5.000	90.407	37.323	0.000
Residual	479.611	198.000	2.422		
Total	931.647	203.000			

Figures 4-6 through 4-8 show the results of common tests for normality.

Distribution of variance appears to be roughly the same as for the overall model with a smaller number of total sample points on the plot. The Wilk-Shapiro/Rankit plot also appears linear, though not as linear as the overall model. The distribution on the histogram of residuals supports the belief that assumptions of normality are most likely still appropriate, though not as much as in the overall sample.

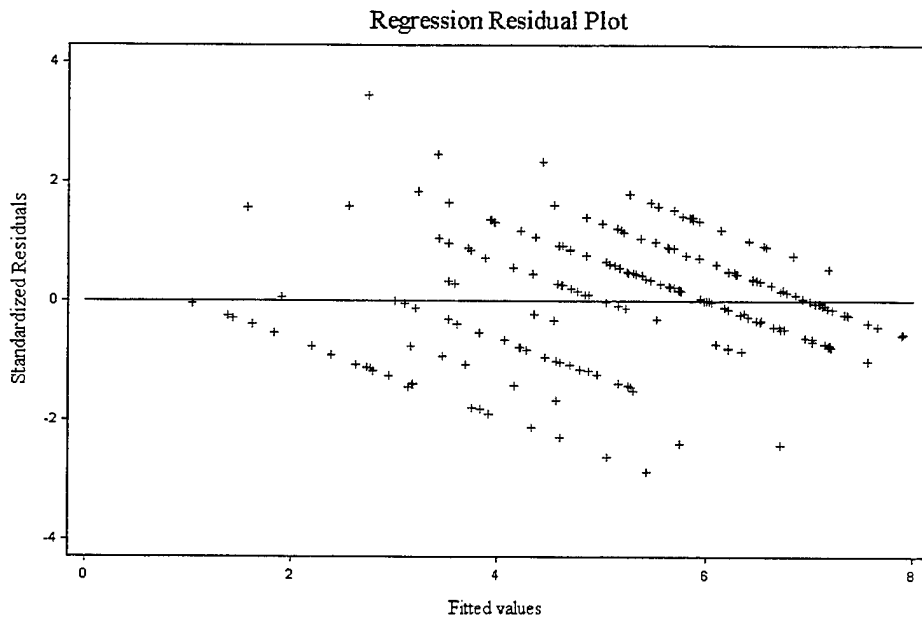


Figure 4-6. Tests of Normality for Civilian Model – Residual Plot

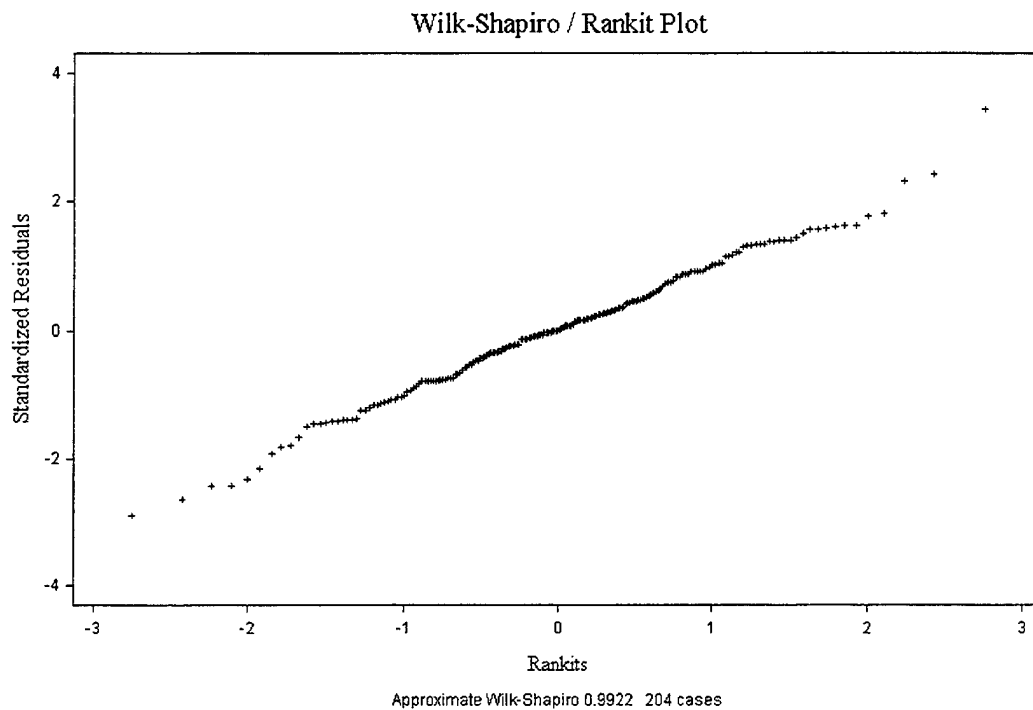


Figure 4-7. Tests of Normality for Civilian Model - Q-Q Plot

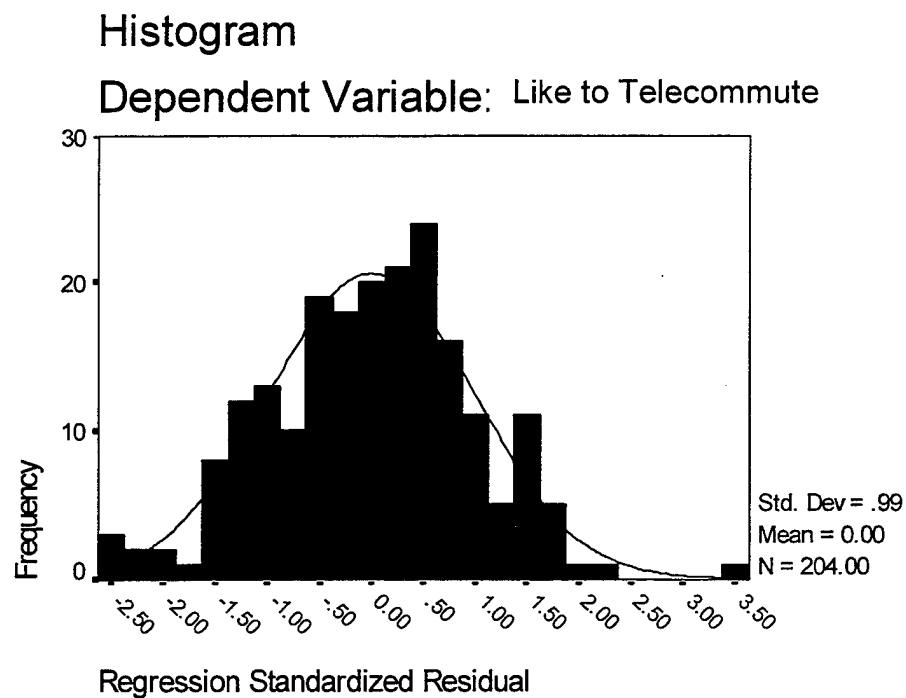


Figure 4-8. Tests of Normality for Civilian Model – Regression Residuals

Military Model

Descriptive statistics for the military model (derived by analyzing the 233 military respondents in the sample) are presented in Table 4-7 and Figure 4-9. Of the military model, 91.1% prefer some form of telecommuting, while 84.5% believe their job environment will allow it. Of the sample, 36.5% of respondents stated a preference for traditional telecommuting, while 55.8% felt the job environment would permit it.

Table 4-7. Military Model Descriptive Statistics

Item	Mean	Std. Dev.
Allow More Work Done	3.53	1.17
Extent of TC Job Allows	4.30	2.12
Allow Time for Myself	3.44	1.22
Importance of Reducing Commute Stress	3.97	0.91
Importance of Work Social Interactions	3.41	1.07
Importance of Ed/Personal Interests	4.14	0.85
Professional/Technical Occupation	0.51	0.50
Like to Telcommute	5.00	2.25

N=233

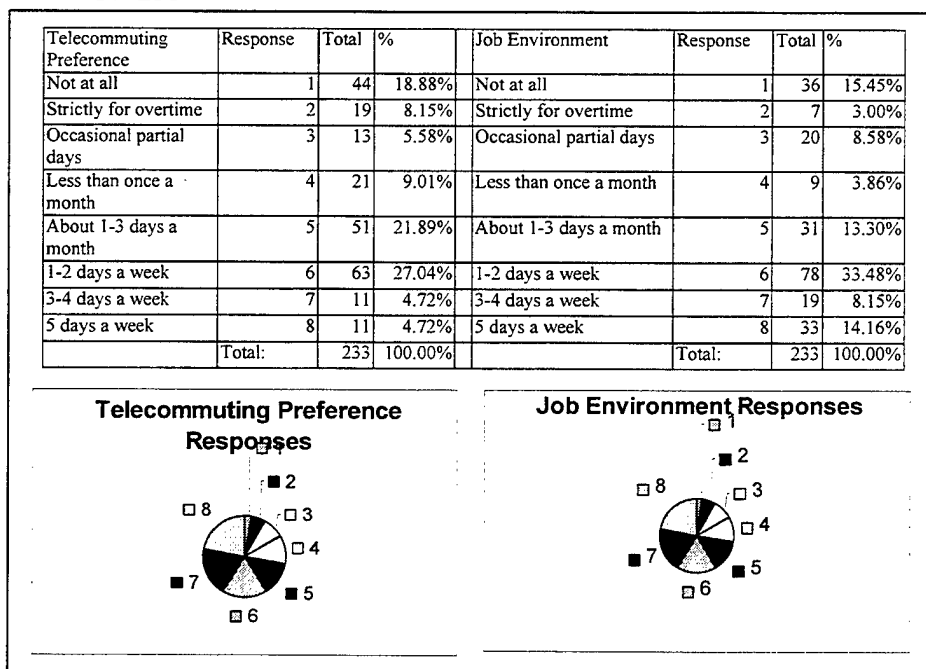


Figure 4-9. Military Model Telecommuting Preference and Job Environment Response Frequencies

Correlations between items for the military sub-sample are shown in Table 4-8. Only items significant in the model were included in the table.

Table 4-8. Pearson's Correlations for Military Model

INTERCORRELATION MATRIX							
		1	2	3	4	5	6
1	Allow More Work Done						
2	Extent of TC Job Allows	0.37*					
3	Allow Time for Myself	0.45*	0.24*				
4	Importance of Reducing Commute Stress	0.50*	0.30*	0.36*			
5	Importance of Work Social Interactions	-0.26*	-0.12	-0.17*	-0.29*		
6	Importance of Ed/Personal Interests	0.19*	0.19*	0.27*	0.25*	-0.11	
7	Professional/Technical Occupation	-0.18*	-0.10	-0.07	-0.14*	0.03	-0.04

N=233 *:p<.05

A summary of the military model is presented in Table 4-9. The model consisted of seven items with p-values of .05 or less. The constant term is not significant for this model (p=.122). The model ANOVA shows the military model is statistically significant. The model R-squared was .55, which indicates this model contains more predictive power than the overall model. This was true although this model uses seven predictor variables versus the overall model's eight. This model shares three factors with the overall model. These are "Allow More Work Done," "Extent of Telecommuting Job Allows," and "Allow Time for Myself."

Table 4-9. Military Regression Analysis Predicting Like to Telecommute

Model Summary							
	Variables				Standardized Coefficients		
Model	Entered	R	R Square	Adjusted R Square	Beta	t	p
1	Allow More Work Done	0.54	0.30	0.29	0.196	3.425	0.001
2	Extent of TC Job Allows	0.63	0.40	0.39	0.280	5.699	0.000
3	Allow Time for Myself	0.69	0.48	0.47	0.262	5.018	0.000

Table 4-9. (continued)

4	Importance of Reducing Commute Stress	0.72	0.52	0.51	0.194	3.549	0.000
5	Importance of Work Social Interactions	0.73	0.53	0.52	-0.105	-2.211	0.028
6	Importance of Ed/Personal Interests	0.73	0.54	0.52	0.10	2.15	0.03
7	Professional/Technical Occupation	0.74	0.55	0.53	0.10	2.14	0.03

ANOVA

Model	Sum of Squares	df	Mean Square	F	p
Regression	644.352	7.000	92.050	38.739	0.000
Residual	534.643	225.000	2.376		
Total	1178.996	232.000			

Figures 4-10 through 4-12 show the results of common tests for normality. Distribution of variance appears to be better than the overall model although it has a smaller number of total sample points on the plot. The Wilk-Shapiro/Rankit plot also appears linear, though not as linear as the overall model. The distribution on the histogram of residuals supports the other indicators in showing that assumptions of normality are most likely still appropriate.

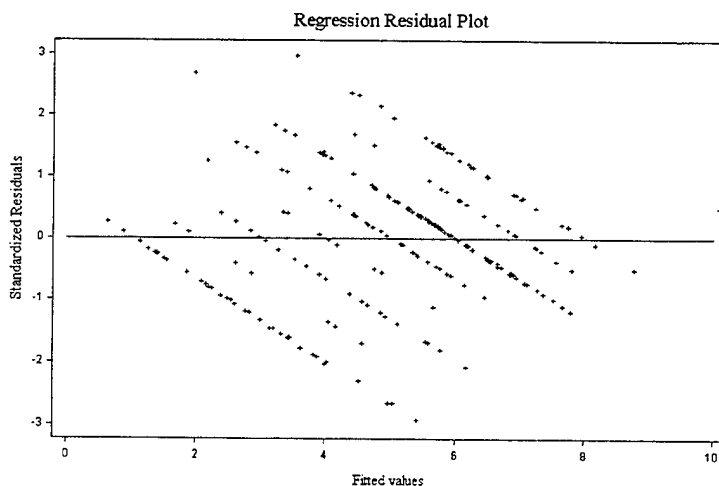


Figure 4-10. Tests of Normality for Military Model – Residual Plot

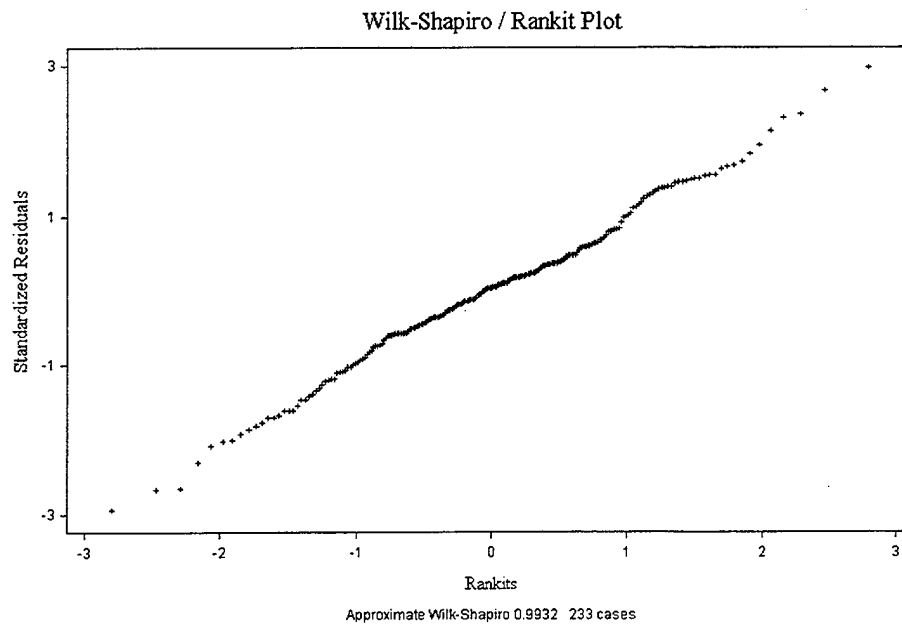


Figure 4-11. Tests of Normality for Military Model – Q-Q Plot

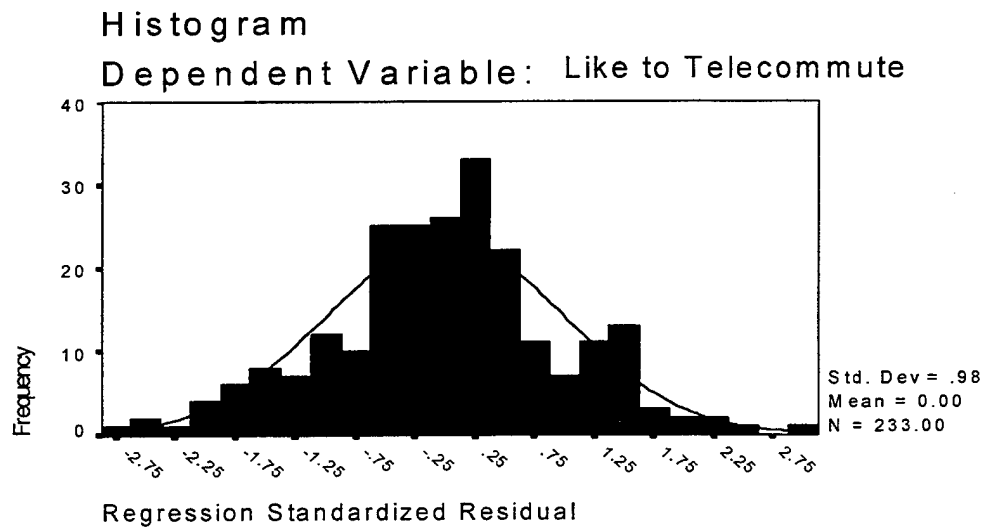


Figure 4-12. Tests of Normality for Military Model – Regression Residuals

Officer Model

Descriptive statistics for the officer model (derived by analyzing all officer respondents in the sample: N=130) are presented in Table 4-10 and Figure 4-13. Of the officer model, 89.2% prefer some form of telecommuting, while 88.5% believe their job environment will allow it. Of the sample, 61.5% of respondents stated a preference for traditional telecommuting, while 41.5% felt the job environment would permit it.

Table 4-10. Officer Model Descriptive Statistics

Item	Mean	Std. Dev
Extent of TC Job Allows	4.59	1.96
Allow Time for Myself	3.54	1.23
Allow More Work Done	3.46	1.16
Marital Status	1.24	0.43
Like to Telecommute	5.16	2.02

N=130

Telecommuting Preference	Response	Total	%	Job Environment	Response	Total	%
Not at all	1	14	10.77%	Not at all	1	15	11.54%
Strictly for overtime	2	4	3.08%	Strictly for overtime	2	13	10.00%
Occasional partial days	3	12	9.23%	Occasional partial days	3	9	6.92%
Less than once a month	4	4	3.08%	Less than once a month	4	7	5.38%
About 1-3 days a month	5	16	12.31%	About 1-3 days a month	5	32	24.62%
1-2 days a week	6	56	43.08%	1-2 days a week	6	42	32.31%
3-4 days a week	7	11	8.46%	3-4 days a week	7	7	5.38%
5 days a week	8	13	10.00%	5 days a week	8	5	3.85%
Total:		130	100.00%	Total:		130	100.00%

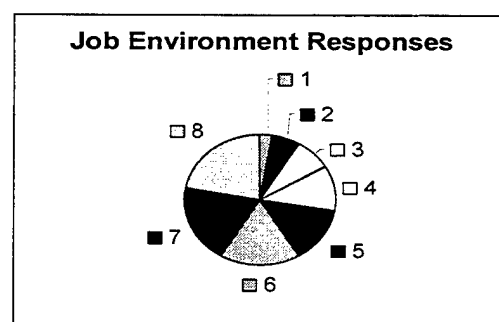
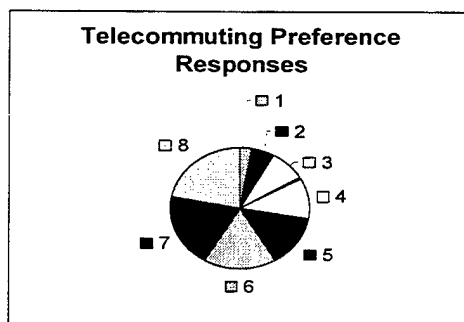


Figure 4-13. Officer Model Telecommuting Preference and Job Environment Response Frequencies

Correlations between items for the officer sub-sample are shown in Table 4-11.

Only items significant in the model were included in the table.

Table 4-11. Pearson's Correlations for Officer Model

INTERCORRELATION MATRIX				
		1	2	3
1	Extent of TC Job Allows			
2	Allow Time for Myself	0.23*		
3	Allow More Work Done	0.37*	0.37*	
4	Marital Status	-0.05	-0.04	-0.16

N=130 *:p<.05

A summary of the officer model is presented in Table 4-12. The model consisted of four items with p-values of .05 or less. The constant term is not significant for this model (p=.061). The model ANOVA shows the officer model is statistically significant. The model R-squared was .54, which indicates it has more predictive power than the overall model. This was true although this model uses four predictor variables versus the overall model's eight. This model shares three factors with the overall model. These are "Allow More Work Done," "Extent of Telecommuting Job Allows," and "Allow Time for Myself."

Table 4-12. Officer Regression Analysis Predicting Like to Telecommute

Model Summary							
	Variables				Standardized Coefficients		
Model	Entered	R	R Square	Adjusted R Square	Beta	t	p
1	Extent of TC Job Allows	0.56	0.32	0.31	0.40	6.04	0.00
2	Allow Time for Myself	0.67	0.45	0.44	0.30	4.48	0.00
3	Allow More Work Done	0.71	0.50	0.49	0.24	3.36	0.00
4	Marital Status	0.73	0.54	0.52	-0.18	-2.94	0.00

Table 4-12. (continued)

ANOVA

Model	Sum of Squares	df	Mean Square	F	p
Regression	281.425	4.000	70.356	36.016	0.000
Residual	244.183	125.000	1.953		
Total	525.608	129.000			

Figures 4-14 through 4-16 show the results of common tests for normality.

Distribution of variance appears to be questionable in the left side of the plot. The Wilk-Shapiro/Rankit plot appears linear, possibly better than the overall model. The distribution on the histogram of residuals supports the other indicators in showing that assumptions of normality are most likely still appropriate.

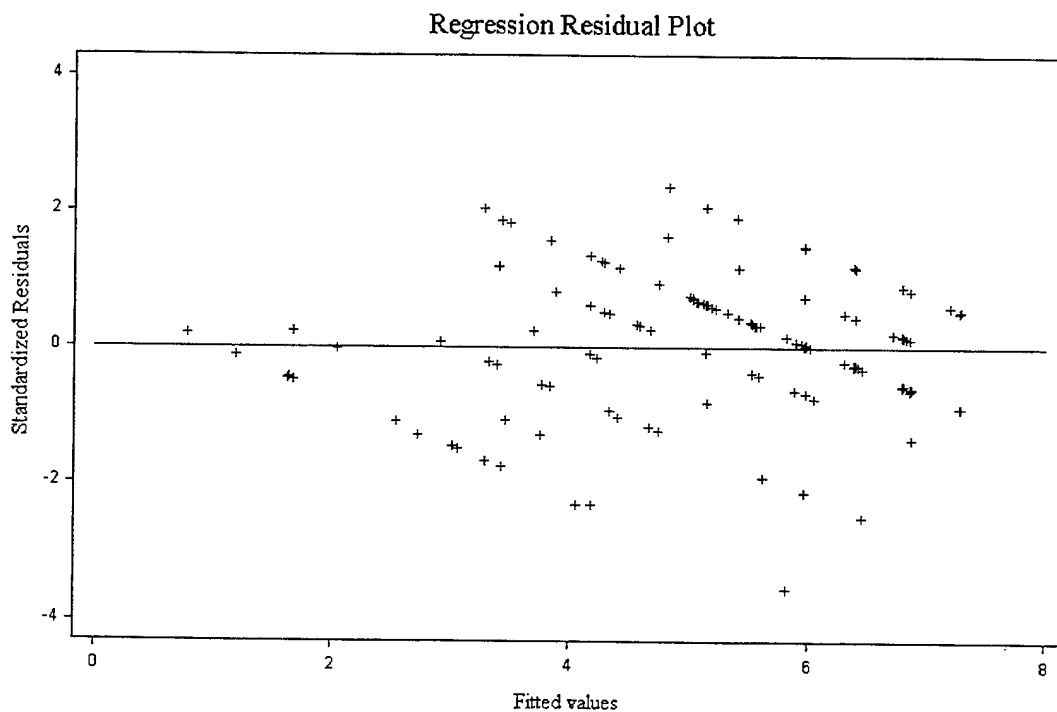


Figure 4-14. Tests of Normality for Officer Model – Residual Plot

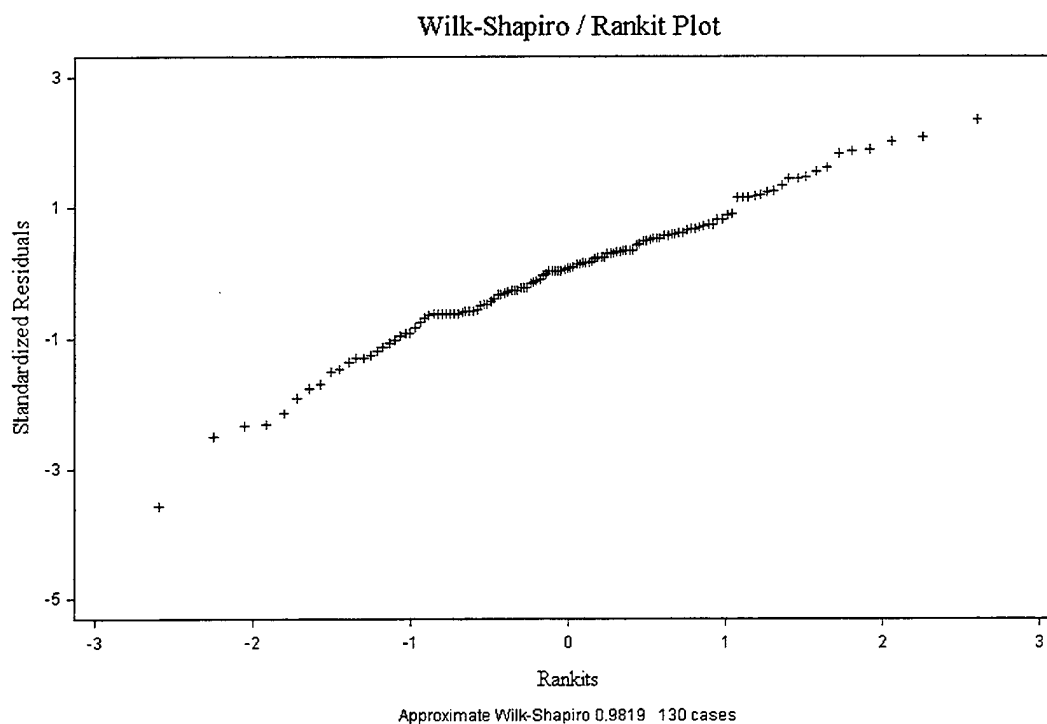


Figure 4-15. Tests of Normality for Officer Model – Q-Q Plot

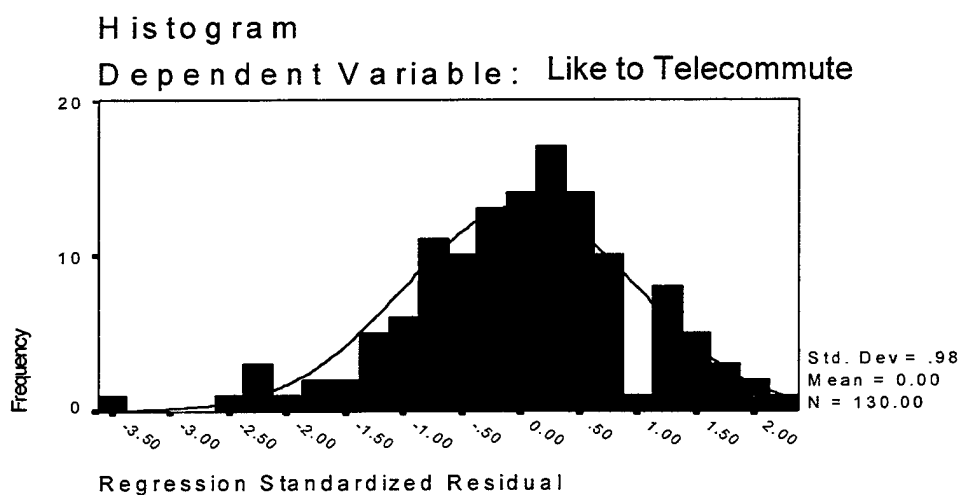


Figure 4-16. Tests of Normality for Officer Model – Regression Residuals

Enlisted Model

Descriptive statistics for the enlisted model (derived by analyzing all enlisted respondents in the sample) are presented in Table 4-13 and Figure 4-17. Of the enlisted model, 78.6% prefer some form of telecommuting, while 71.8% believe their job environment will allow it. Of the sample, 48.6% of respondents stated a preference for traditional telecommuting, while 30.1% felt the job environment would permit it.

Table 4-13. Enlisted Model Descriptive Statistics

Item Name	Mean	Std. Dev.
Allow More Independence	3.76	1.01
Extent of TC Job Allows	3.94	2.27
Reduce Stress in Main Office	3.66	1.19
Importance of Easier Dependent Care	3.60	0.93
Sex	1.47	0.50
Will Increase Family Conflict	2.56	1.18
Importance of Work Professional Interactions	3.40	1.02
Like To Telecommute	4.81	2.52

N=103

Telecommuting Preference	Response	Total	%	Job Environment	Response	Total	%
Not at all	1	22	21.36%	Not at all	1	29	28.16%
Strictly for overtime	2	3	2.91%	Strictly for overtime	2	6	5.83%
Occasional partial days	3	8	7.77%	Occasional partial days	3	4	3.88%
Less than once a month	4	5	4.85%	Less than once a month	4	14	13.59%
About 1-3 days a month	5	15	14.56%	About 1-3 days a month	5	19	18.45%
1-2 days a week	6	22	21.36%	1-2 days a week	6	21	20.39%
3-4 days a week	7	8	7.77%	3-4 days a week	7	4	3.88%
5 days a week	8	20	19.42%	5 days a week	8	6	5.83%
Total:		103	100.00%	Total:		103	100.00%

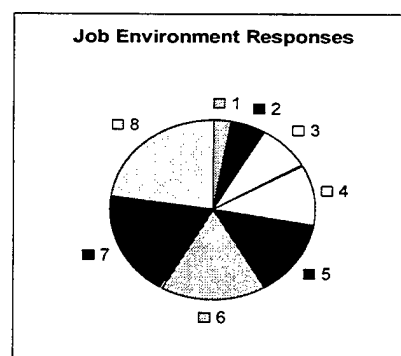
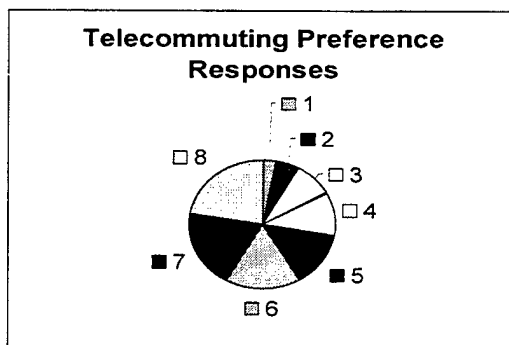


Figure 4-17. Enlisted Model Telecommuting Preference and Job Environment Response Frequencies

Correlations between items for the enlisted sub-sample are shown in Table 4-14.

Only items significant in the model were included in the table.

Table 4-14. Pearson's Correlations for Enlisted Model

INTERCORRELATION MATRIX							
		1	2	3	4	5	6
1	Allow More Independence						
2	Extent of TC Job Allows	0.19*					
3	Reduce Stress in Main Office	0.56*	0.13				
4	Importance of Easier Dependent Care	0.50*	0.19*	0.41*			
5	Sex	0.11	-0.07	0.27*	0.21*		
6	Will Increase Family Conflict	-0.15	-0.05	-0.26*	-0.03	-0.05	
7	Importance of Work Professional Interactions	-0.29*	0.02	-0.38*	-0.24*	-0.17	0.27*

N=103 *p<.05

A summary of the enlisted model is presented in Table 4-15. The model consisted of seven items with p-values of .05 or less. The constant term is not significant for this model ($p=.064$). Model ANOVA shows the enlisted model is statistically significant. The model R-squared was .63, which indicates, this model has more predictive power than the overall model. This was true although this model uses seven predictor variables versus the overall model's eight. This model shares two factors with the overall model. These are "Reduce Stress in the Main Office" and "Extent of Telecommuting Job Allows."

Table 4-15. Enlisted Regression Analysis Predicting Like to Telecommute

Model Summary							
	Variables				Standardized Coefficients		
Model	Entered	R	R Square	Adjusted R Square	Beta	t	Sig.
1	Allow More Independence	0.55	0.31	0.30	0.19	2.28	0.02
2	Extent of TC Job Allows	0.64	0.42	0.40	0.26	4.05	0.00
3	Reduce Stress in Main Office	0.70	0.50	0.48	0.34	4.09	0.00
4	Importance of Easier Dependent Care	0.73	0.54	0.52	0.32	4.28	0.00

Table 4-15. (continued)

5	Sex	0.76	0.58	0.56	-0.21	-3.11	0.00
6	Will Increase Family Conflict	0.79	0.62	0.59	-0.23	-3.43	0.00
7	Importance of Work Professional Interactions	0.80	0.63	0.61	0.14	2.08	0.04

ANOVA

Model	Sum of Squares	df	Mean Square	F	p
Regression	409.346	7	58.478	23.463	.000
Residual	236.771	95	2.492		
Total	646.117	102			

Figures 4-18 through 4-20 show the results of common tests for normality.

Distribution of variance appears to be acceptable for assumptions of normality in analysis. The Wilk-Shapiro/Rankit plot also appears linear, though not as linear as the overall model. The distribution on the histogram of residuals appears reasonable for the sample size.

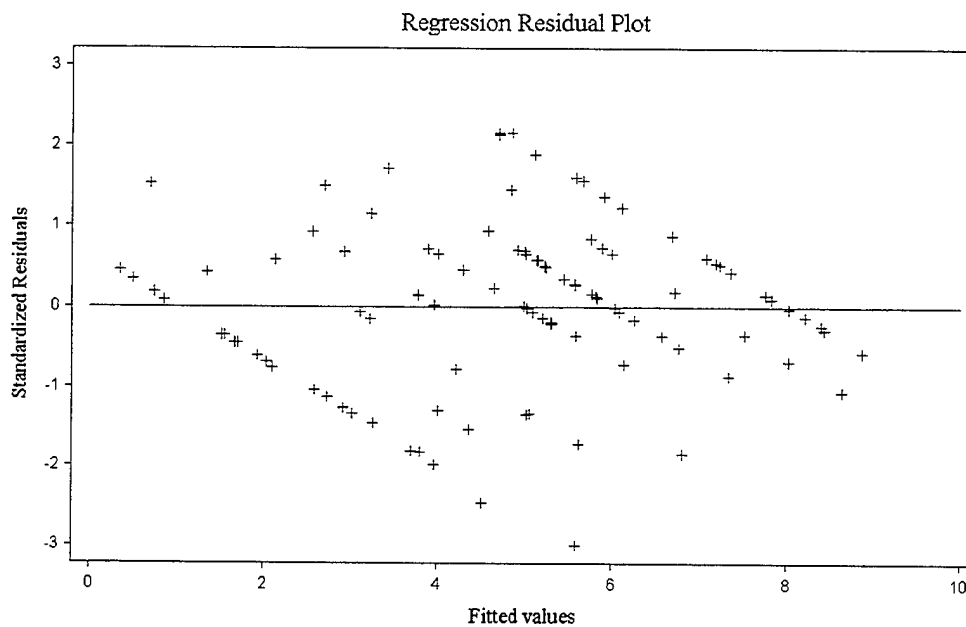


Figure 4-18. Tests of Normality for Enlisted Model – Residual Plot

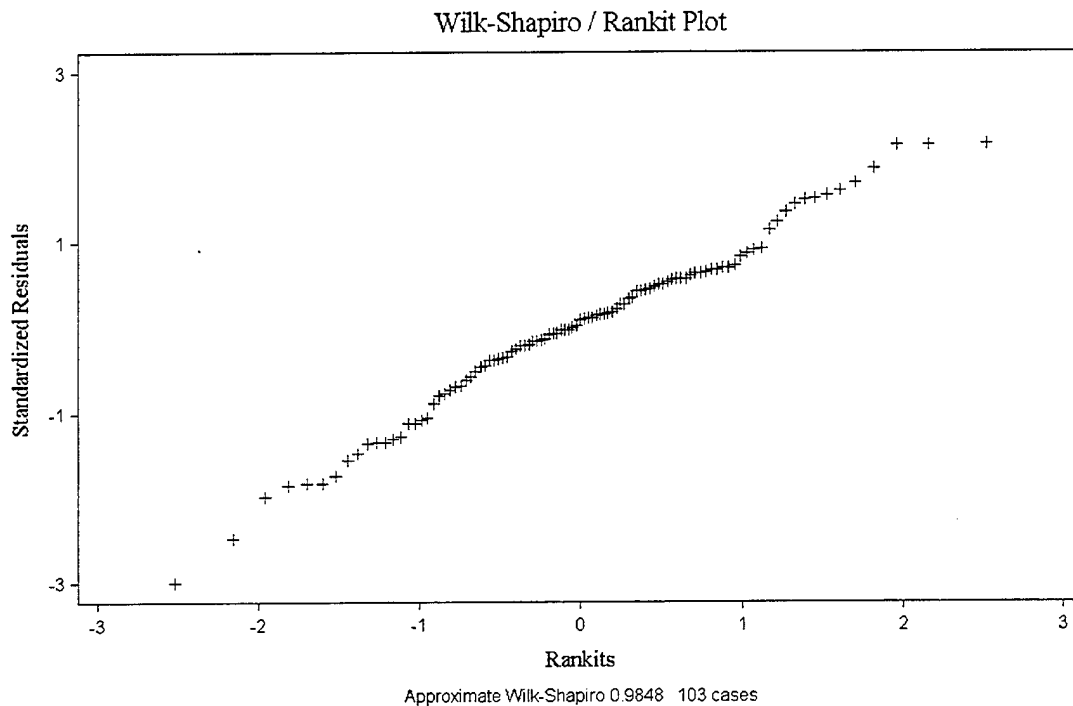


Figure 4-19. Tests of Normality for Enlisted Model – Q-Q Plot

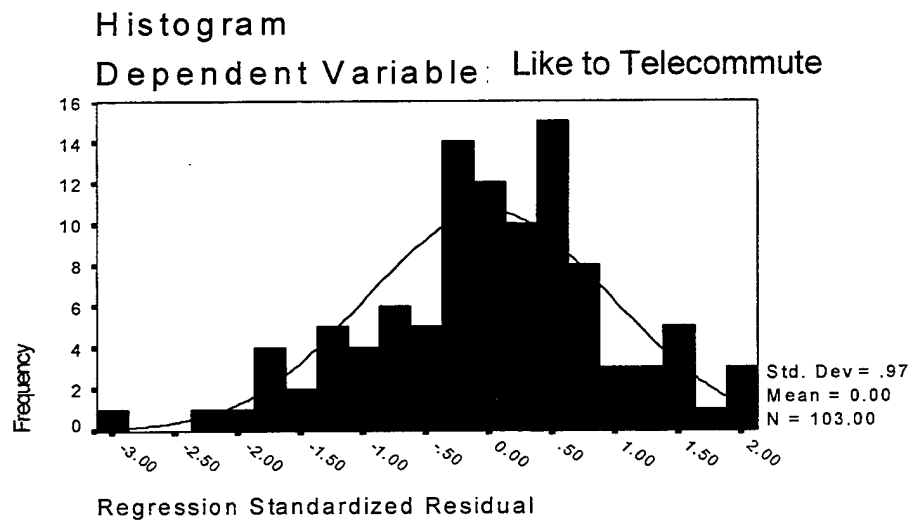


Figure 4-20. Tests of Normality for Enlisted Model – Regression Residuals

Model Comparisons

Table 4-16 provides a comparison of the significant variables entering into the different preference models. For each item, the item description is given on the left, while the second column references models that the item entered significantly. The third column gives the Beta weight for the particular regression model, while the variable's significance in the model is shown in the fourth column. Note that only one variable (Extent of TC Job Allows) was significant in all models. Alternatively, three variables (Can Work While Perm. Disabled, Number of Children 0-5 Yrs Old, and Use Commute Time Productively) were unique to the overall model. Twelve other variables appeared only once in a particular model.

Table 4-16. Summary of Significant Items

Items in Any Model .05>p: * .01>p: **			
Item Name	Model	Beta	Sig.
Allow More Independence	Enlisted	0.19	*
Allow More Work Done	Civilian	0.21	**
	Military	0.20	**
	Officer	0.24	**
	Overall	0.18	*
Allow Time for Myself	Military	0.26	**
	Officer	0.30	**
	Overall	0.18	**
Can Work While Permanently Disabled	Overall	0.08	*
Extent of TC Job Allows	Civilian	0.35	**
	Enlisted	0.26	**
	Military	0.28	**
	Officer	0.40	**
	Overall	0.35	**
Importance of Easier Dependent Care	Enlisted	0.32	**
Importance of Educational/Personal Interests	Military	0.10	*
Importance of Reducing Commute Stress	Military	0.19	**
Importance of Time With Family	Civilian	0.11	*
	Overall	0.10	**
Importance of Work Professional Interactions	Enlisted	0.14	*

Table 4-16. (continued)

Importance of Work Social Interactions	Military	-0.11	*
Marital Status	Officer	0.10	**
Number of Children 0-5 Yrs	Overall	0.12	*
Preference for Work Professional Interaction	Civilian	-0.16	**
Professional/Technical Occupation	Military	0.10	*
Reduce or Eliminate Commute Time	Civilian	0.21	**
Reduce Stress in Main Office	Enlisted	0.34	**
	Overall	0.12	*
Sex	Enlisted	-0.21	**
Use Commute Time Productively	Overall	-0.09	**
Will Increase Family Conflict	Enlisted	-0.23	**

T-Tests

T-tests were performed between the groups: civilian, military, officer, and enlisted. There were no significant differences between any groups based on Like to Telecommute, however, there were significant differences between officers and the rest of the population based on Extent of Telecommuting Job Allows (see Table 4-17). The relationship for enlisted was negative and tenuous ($p=.09$). Effectively, officers feel that their jobs should allow MORE telecommuting than the overall population. There was also a significant difference between the service/repair and production occupations and the rest of the population.

Table 4-17. Two-Sample T-tests for Sub-samples

Sub-sample	Sub-sample Mean	Overall Sample Mean	Difference	t	p	Sub-sample Size
Officer	4.59	4.13	.46	2.14	.03	130
Enlisted	3.94	4.36	-.42	1.71	.09	103
Service/Repair	3.00	4.34	-1.34	2.86	.00	23
Production	2.11	4.31	-2.20	3.00	.00	9

In order to confirm that, in general, people prefer to telecommute more often than the job allows, a series of paired t-tests was run for each population for the difference

between Like to Telecommute and Extent of Telecommuting Job Allows. The difference was found significant at $p < .05$ for each group and sub-group. These results are shown in Table 4-18.

Table 4-18. Paired T-Test for Like to Telecommute vs. Extent of Telecommuting Job Allows for Overall Model

Sample/Sub-sample	Difference in Means Between Like to Telecommute and Extent of Telecommuting Job Allows	t	p	Sub-sample Size
Overall	.81	8.02	.00	449
Civilian	.98	6.55	.00	204
Military	.70	4.86	.00	233
Officer	.57	3.49	.00	130
Enlisted	.86	3.43	.00	103

5. Discussion

After the analysis of data in chapter 4, the implications of the analysis must be considered. This chapter will explore the meaning of the results. First, the results from the linear models will be discussed. The usefulness of the linear model will be explored, along with factors that the model identifies. Comparisons will be made with other research results. An attempt will also be made to explain the findings of the t-tests. Second, the implications of this research for the Air Force telecommuting program will be explored. Specifically, this chapter will discuss which groups (civilian, military, officer, enlisted) seem to be best-suited for telecommuting, which of the advantages/disadvantages of telecommuting can be reasonably expected to be realized, and the degree of participation stated preferences and job environment responses appear to indicate. Third, the limitations of the research will be explored. These include limitations of the instrument, sample limitations, mathematical limitations of the analysis, and issues concerning the validity of survey instrument measures. The final section will address suggestions for future research. Suggestions will be made about additional areas of study, different survey structures, reliability issues, and exploring differences and similarities between populations.

Interpretation of Results

In determining the usefulness of the linear model of telecommuting behavior, it is first necessary to answer the question of whether a linear model of telecommuting behavior is meaningful. The meaningfulness of the model can be addressed in two ways. First, is the model mathematically useful for prediction purposes? Second, is the model

useful to decision makers who will use it as the basis for decisions about telecommuting program implementation?

The analysis of mathematical usefulness of the five different models was carried out in Chapter 4. Each of the models showed R-squared values of .49 or above and ANOVA results showing that each model was statistically significant. The assumptions of normality are also met; thus, it can be assumed that the models are useful predictors of telecommuting preference. All models, individually, met these criteria.

On a practical level, the usefulness of the model should be judged more by its usefulness for the decision-maker. The particular usefulness of this model can be judged by what forms of telecommuting the decision-makers are considering. If the only form of telecommuting that will be considered for a program is an all-day every day, or all-day at least once a week, then all of the different levels of these models will not be useful. Options such as "strictly for overtime," "less than once a month," and "about 1-3 days a month," would not be meaningful in this scenario, and a binary telecommuting model may be more appropriate. Since the Air Force is still in the early stages of developing its telecommuting program criteria, the shape of the telecommuting process has not been finalized. Therefore, because any telecommuting option may be meaningful under this scenario, using a linear telecommuting preference model seems reasonable.

Having concluded that the models are useful and potentially meaningful, the question of which reasons/factors are correlated to telecommuting preference can be answered. From Table 4-16, it is readily apparent that only two factors appeared in all models. It therefore seems unlikely that the significant factors affecting telecommuting preference for one group will necessarily affect preferences in another group. The two

“universal factors” are “Allow More Work Done” and “Extent of Telecommuting Job Allows.” By themselves, these factors account for R-squared values of between .39 and .43 for all models. Also, by themselves, they have significant Beta coefficients in each model ($p < .05$). Beyond these two factors, the preferences of different populations appear to differ.

Having isolated the most meaningful factors across populations, the issue of whether these factors are generalizable to other populations should be addressed. Using the stated preference models from Chapter 2 as a comparison, it can be seen that Mokhtarian and Salomon (1997:46) included the item “Amt. Of Telecommuting Job Allows” in their final model ($\beta = .83$, $t = 5.83$). However, the item “Allow More Work Done” did not enter significantly. The item “Allow More Work Done” was included as a common factor with “Work and Family Drives” and “Work and Travel” drives. The factors that included “Allow More Work Done” did appear in the final model. Bernardino et al. (1993:27) found that respondents generally agreed on a scale of 1 to 10 that telecommuting would increase productivity (Mean=7.65, Std. Dev.=1.96). Arguably, this item is comparable to “getting more work done.” The item was not significant in their telecommuting preference model. For the “Extent of Telecommuting Job Allows,” Bernardino et al. included a binary equivalent (“dummy, if telecommuting option is not available”) which was found to be significant in their probit analysis (Mean=.608, Std. Dev.=.134, $t = 2.70$). Finally, the Mahmassani et al. model did not use items similar enough to “Extent of Telecommuting Job Allows” and “get more work done” to draw a meaningful comparison.

By comparing current results to other stated-preference models, there appears to be some similarity in the findings across studies.

In Table 4-17, t-tests were conducted to confirm that apparent trends or “intuitive” beliefs could be supported. The lack of significance in t-tests for “Like to Telecommute” between jobs appears to indicate there is no significant difference in telecommuting preference based on occupation. In general, one would assume that service/repair workers and production workers would not be interested in telecommuting options to the same extent as the rest of the population. However, t-tests could not confirm this hypothesis. What they did confirm was that the workers in service/repair jobs consider the “Extent of Telecommuting the Job Allows” to be significantly lower than the general sample. The finding that officers were significantly ($p=.03$) more likely than the remainder of the population to believe that their jobs allowed a greater extent of telecommuting was not anticipated. On the other hand, enlisted respondents rated the degree to which their job allowed telecommuting lower than the rest of the sample at a marginally significant level ($p=.09$). Because officer and enlisted are both military, these findings argue against treating the military as a single group when making telecommuting decisions.

The paired t-tests in Table 4-18 compared “Extent of Telecommuting Job Allows” to ratings of “Like to Telecommute.” For the overall sample and for each sub-sample, “Like to Telecommute” was rated significantly higher than “Extent of Telecommuting Job Allows.” This led to the conclusion that the sample, in general, preferred to telecommute at a level greater than that allowed by their job environment. For all five sub-samples, the t-tests found that this was the case at a significant level ($p<.0005$).

From these tests, it seems reasonable to assume that the limiting factor on telecommuting is not preference, but the perceived limits of the job environment.

Implications for the Air Force Telecommuting Program

The Air Force Telecommuting program may make use of the data from this research in a variety of ways. The data may be used to target a specific group based on its telecommuting preference, to determine which minimum level of telecommuting is required to realize the advantages the Air Force is trying to realize, and to estimate potential telecommuting participation.

In determining which group to target, two findings seem useful as guidance. First, for every sample subgroup, telecommuting preference is higher than the perceived job environment allows. Second, in this important area, officers had the highest rating of perceived "Extent of Telecommuting Job Allows." These findings would indicate that officers would make a good target group to introduce a telecommuting program. Following officers, based on job characteristics, civilians would be second most appropriate, followed by enlisted personnel.

Another use of this data might be to provide a general idea of the advantages/disadvantages of telecommuting and to estimate the proportion of workers interested and capable of telecommuting at each level. Table 5-1 shows the cumulative percentages of overall, civilian, officer, and enlisted respondents who expressed a preference for each telecommuting option. Table 5-2 shows the cumulative percentages of overall, officer, and enlisted respondents who felt their jobs would allow each level of telecommuting.

Table 5-1. Cumulative Percentages of Overall, Civilian, Officer, and Enlisted Respondents Preferring Each Telecommuting Option

Telecommuting Preference	Overall Cum %	Civilian Cum %	Officer Cum %	Enlisted Cum %
5 days a week	11.80%	8.82%	10.00%	19.42%
3-4 days a week	25.83%	30.39%	18.46%	27.19%
1-2 days a week	57.23%	59.80%	61.54%	48.55%
About 1-3 days a month	70.15%	71.56%	73.85%	63.11%
Less than once a month	73.71%	74.01%	76.93%	67.96%
Occasional partial days	83.06%	84.79%	86.16%	75.73%
Strictly for overtime	86.18%	88.22%	89.24%	78.64%
Not at all	100.00%	100.00%	100.00%	100.00%

Table 5-2. Cumulative Percentages of Overall, Civilian, Officer, and Enlisted Respondents Perceptions of Extent of Telecommuting Job Allows

Telecommuting Job Allows	Overall Cum %	Civilian Cum %	Officer Cum %	Enlisted Cum %
5 days a week	4.01%	1.96%	3.85%	5.83%
3-4 days a week	12.25%	14.71%	9.23%	9.71%
1-2 days a week	38.75%	41.67%	41.54%	30.10%
About 1-3 days a month	56.57%	54.91%	66.16%	48.55%
Less than once a month	64.81%	61.77%	71.54%	62.14%
Occasional partial days	72.16%	70.59%	78.46%	66.02%
Strictly for overtime	78.17%	74.51%	88.46%	71.85%
Not at all	100.00%	100.00%	100.00%	100.00%

An analysis of advantages/disadvantages can be accomplished by evaluating which advantages/disadvantages would be attained at each level of telecommuting, determining the percentage of the prospective population who feel that jobs would allow that level of telecommuting and making a subjective judgement as to what the lowest acceptable level of telecommuting is that will give satisfactory results. The following paragraphs will analyze the advantages/disadvantages likely to be associated with each level of telecommuting and include the cumulative preference and extent of telecommuting that jobs allow for each group at that level of telecommuting.

Telecommuting Strictly for Overtime. Table 5-3 shows the advantages/disadvantages of telecommuting that potentially could be realized by telecommuting strictly for overtime, along with the cumulative percentages of populations that wanted to participate at this level and the cumulative percentage of those who felt their jobs would allow it. Note that, at this level of telecommuting, a small subset of telecommuting advantages/disadvantages come into play. In terms of “family friendliness,” allowing workers to complete overtime at home enables workers to spend more time in the home with their families, which creates the potential for work/family conflict.

Table 5-3. Cumulative Percentages of Responses for “Strictly for Overtime” and Associated Advantages/Disadvantages

Response Option	Overall Cum %	Civilian Cum %	Officer Cum %	Enlisted Cum %
Telecommuting Preference	86.18%	88.22%	89.24%	78.64%
Telecommuting Allowed by job	78.17%	74.51%	88.46%	71.85%
Advantages		Disadvantages		
For the Air Force				
Improved quality of work output		Security concerns		
Increased productivity		Potential union opposition		
		Start-up and operation costs		
For the Individual				
Increased scheduling flexibility		Loss of support services		
Improved work environment		May cause overworking		
Stronger family ties		Removal of work/life boundaries		
		Household conflicts		

Telecommuting Occasional Partial Days. Table 5-4 shows the advantages/disadvantages of telecommuting that potentially could be realized by telecommuting occasional partial days, along with the cumulative percentages of respondents that wanted to participate at this level and the cumulative percentage of those

who felt their jobs would allow it. This level of telecommuting is the lowest level that allows for telecommuting during the workday. Because of this characteristic, this telecommuting option allows for changes in travel patterns. For example, leaving early to telecommute at home allows workers to avoid rush-hour traffic and to be in the house when children get home. Additionally, occasional partial-day telecommuting allows flexibility for doctor appointments and similar events where parents require flexibility in scheduling. But they may prefer to work at home to make up the time rather than taking sick leave or annual leave.

Table 5-4. Cumulative Percentages of Responses for “Occasional Partial Days” and Associated Advantages/Disadvantages

Response Option	Overall Cum %	Civilian Cum %	Officer Cum %	Enlisted Cum %
Telecommuting Preference	83.06%	84.79%	86.16%	75.73%
Telecommuting Allowed by job	72.16%	70.59%	78.46%	66.02%
Advantages		Disadvantages		
For the Air Force				
Improved quality of work output		Security concerns		
Increased productivity		Potential union opposition		
Reduced absenteeism and sick leave		Start-up and operation costs		
Improved ease of handling schedule fluctuations		Difficulty of remote supervision		
Improved ease of handling for emergency situations		Health and safety issues		
For the Individual				
Increased scheduling flexibility		Loss of support services		
Improved work environment		May cause overworking		
Stronger family ties		Removal of work/life boundaries		
Decreased commuting time, work expenses, and stress		Household conflicts		

Telecommuting Less than Once a Month and About 1-3 Days a Month. Table 5-5 indicates the cumulative percentages of populations that wanted to participate in telecommuting less than once a month and the cumulative percentages of those who felt

their jobs would allow it. These levels of telecommuting are the minimum levels that involve telecommuting for a full day. However, telecommuting occurs with a low enough frequency that it would not be considered a modified work week. Because of these characteristics, these options share advantages and disadvantages that are more in common with telecommuting for overtime or telecommuting for partial days than with weekly telecommuting options. Because advantages and disadvantages do not change materially from Table 5-4, Table 5-5 shows only the cumulative percentages for each option.

Table 5-5. Cumulative Percentages of Responses for "Less Than Once a Month" and "1-3 Days a Month"

Response Option	Overall Cum %	Civilian Cum %	Officer Cum %	Enlisted Cum %
Less than once a month				
Telecommuting Preference	73.71%	74.01%	76.93%	67.96%
Telecommuting Allowed by job	64.81%	61.77%	71.54%	62.14%
1-3 days a month				
Telecommuting Preference	70.15%	71.56%	73.85%	63.11%
Telecommuting Allowed by job	56.57%	54.91%	66.16%	48.55%

Telecommuting 1-2 Days a Week and 3-4 Days a Week. Table 5-6 shows the cumulative percentages of populations that wanted to telecommute for 1-2 days a week or less and 3-4 days a week or less and the cumulative percentages of those who felt their jobs would allow telecommuting at these levels. These levels of telecommuting are the levels typically considered in common usage for the term "telecommuting." It is at these telecommuting levels that the majority of advantages/disadvantages derived from telecommuting come into effect. Note that the maximum percentage in a sample that thought 3-4 days a week was a viable option was 14.71% in the civilian population.

Between the two options, the difference was at least 20% decrease for each population subgroup when going from 1-2 days a week to 3-4 days a week.

Table 5-6. Cumulative Percentages of Responses for “1-2 Days a Week” and “3-4 Days a Week”

Response Option	Overall Cum %	Civilian Cum %	Officer Cum %	Enlisted Cum %
1-2 Days a Week				
Telecommuting Preference	57.23%	59.80%	61.54%	48.55%
Telecommuting Allowed by job	38.75%	41.67%	41.54%	30.10%
3-4 Days a Week				
Telecommuting Preference	25.83%	30.39%	18.46%	27.19%
Telecommuting Allowed by job	12.25%	14.71%	9.23%	9.71%
Advantages		Disadvantages		
For the Air Force				
Improved quality of work output		Security concerns		
Increased productivity		Potential union opposition		
Reduced absenteeism and sick leave		Start-up and operation costs		
Improved ease of handling schedule fluctuations		Difficulty of remote supervision		
Improved ease of handling for emergency situations		Health and safety issues		
Improved employee recruiting and retention		Difficulty in overcoming organizational-level institutional barriers		
For the Individual				
Increased scheduling flexibility		Loss of support services		
Improved work environment		May cause overworking		
Stronger family ties		Removal of work/life boundaries		
Decreased commuting time, work expenses, and stress		Household conflicts		
Greater job responsibility and autonomy		Detrimental to career advancement		
Performance evaluation based on results		May affect performance appraisal negatively		

Telecommuting 5 Days a Week. Table 5-7 shows the percentages of populations that wanted to telecommute five days a week. Five days a week represents the maximum level of telecommuting possible. At this level, all advantages/disadvantages are present. At this point, the list of applicable

advantages/disadvantages becomes identical to Tables 1-2 and 1-3 from Chapter 1. As a trade-off to the potential usefulness of this telecommuting option, it should be noted that this is the least preferred telecommuting option and the option that received the lowest perceived level of "Telecommuting allowed by job." Notable advantages and disadvantages that occur at this level of telecommuting include significant savings in real-estate and overhead, opportunities for the mobility impaired, and problems with social and professional isolation.

Table 5-7. Cumulative Percentages of Responses for "5 Days a Week"

Response Option	Overall Cum %	Civilian Cum %	Officer Cum %	Enlisted Cum %
5 Days a Week				
Telecommuting Preference	11.80%	8.82%	10.00%	19.42%
Telecommuting Allowed by job	4.01%	1.96%	3.85%	5.83%
Advantages		Disadvantages		
For the Air Force				
Improved quality of work output		Difficulty in overcoming organizational-level institutional barriers		
Increased productivity		Difficulty of remote supervision		
Reduced overhead		Security issues		
Reduced absenteeism and sick leave		Start-up and operation costs		
Improved employee recruiting and retention		Health and safety issues		
Improved ease of handling for schedule fluctuations		Potential union opposition		
Improved ease of handling for emergency situations				
Reduced real-estate costs				
For the Individual				
decreased commuting time, work expenses, and stress		Professional and social isolation		
increased scheduling flexibility		Detrimental to career advancement		
improved work environment		May affect performance appraisal negatively		
greater job responsibility and autonomy		Loss of support services		
performance evaluation based on results		May cause overworking		
employment opportunity for mobility-impaired		Removal of work/life boundaries		

Table 5-7. (continued)

stronger family ties	Forced subcontracting
	May lead to loss of benefits
	Household conflicts

Summary of Telecommuting Options. In summary, the effects of implementing a given telecommuting option are expected to give all the benefits of that option plus the benefits of lower frequency telecommuting options. Therefore, each higher frequency level of telecommuting that is implemented should provide benefits to people telecommuting at that frequency, and every frequency that is lower. On the other hand, if levels of telecommuting that have frequencies of once-a-week or less are not recognized in a telecommuting program, then supervisors may not have the incentive to provide these options to their workers, thus losing any advantages that may be associated with them.

Limitations of Research

This section addresses the major limitations of this research. Attempts to keep the survey instrument compact in order to maximize response rate was the major limitation of the data collection effort. Analysis was also limited due to time considerations. Other limitations of surveys in general and this survey in particular are also given in the following section.

In order to maintain brevity in the survey instrument, the scope of the instrument was limited. Rather than include all items that were significant in other models, only one item from each significant factor in Mokhtarian's (1994) survey was included. When preliminary factor analysis was performed, it was found that none of the significant factors in the model loaded on a common factor. Thus, this survey is composed of single

item factors. This composition severely limits insight into the reliability of the items on the instrument. To develop a survey that can demonstrate factor-level reliability, multiple items would have been required for each factor.

In terms of differences among populations, Mokhtarian's (1995:70) research found that, in addition to differences in job category, there were significant differences between organizations for model development. It was deemed impossible to get representative samples of every organization in the Air Force, so a survey of the general population was selected.

Another limitation of the research was the investigation of second order effects. The construction of the instrument divided responses about advantages/disadvantages into two parts. First, respondents were asked if they believed telecommuting had a particular advantage/disadvantage. Second, they were asked to indicate the relative importance they attached to these advantages/disadvantages. None of the models included both belief in the advantage as a function of telecommuting and relative importance of any given advantage/disadvantage. An argument could be made that some sort of second-order effect may be present that would include both belief that telecommuting has a particular advantage/disadvantage and the relative importance of that advantage/disadvantage. These effects were not investigated.

Other limitations of the research are inherent in the survey approach and the survey instrument. Response bias from surveys being returned only by those with a specific interest in telecommuting was one major limitation. The other limitation was the structure of the instrument. In the instrument the preference for telecommuting was established before respondents were asked to consider the different

advantages/disadvantages associated with telecommuting. Therefore, the preference expressed may have been more “gut-level” rather than a rational result of considering the pros and cons of different telecommuting options in terms of the advantages/disadvantages on the instrument.

Suggestions for Future Research

Data from this research may be used in several ways in addition to the uses it was put to in the current analysis. From the limitations section above, an analysis of second-order effects may be appropriate to determine the structure of rational processes that go into telecommuting preference. Additional analysis may also be performed using a binary approach, such as that used by Mokhtarian (1995). Finally, populations may be analyzed in sub-samples different from those used in this research. For example, models may be developed for male and female respondents, by age, by amount of children, or by other discriminators available from the demographic data collected by the survey instrument. Additional research may be indicated as to why the sub-samples in this research required different models to explain preferences. Why are civilians different from officers and officers different from enlisted?

The fact that a large part of telecommuting preference is indicated by respondents' perception of “Extent of Telecommuting Job Allows” indicates that job environment variables have a significant influence on preference. As a result, further study is warranted into exactly what factors about a job make respondents believe that their job is suitable for a given level of telecommuting. Possible explanations involve corporate policy, attitudes of immediate supervisors, dependence on technology, and perceived portability of work.

Additional research should be conducted in order to improve the knowledge obtained by instruments using stated-preference models. For example, an instrument that uses items that load on a given set of factors would allow for reliability measurements to be made. Additionally, development of a standardized instrument would allow for test-retest reliability measures. Unfortunately, the construct validity of the basic assumptions behind stated-preference models has yet to be demonstrated. Specifically, is there any link between stated preference and actual telecommuting behavior. To study this correlation, data from this, and/or some other, research could be used to perform time-series studies to show the correlation between telecommuting preferences and telecommuting behavior after implementation of a telecommuting program.

Conclusion

This thesis has attempted to add to telecommuting theory by extending the use of existing models to a new sample and to provide useful information to the Air Force about the preferences of its personnel. The linear regression model used in this study was found to produce statistically significant results for the overall sample, and for the civilian, military, officer, and enlisted sub-samples. The two factors that can be said to influence telecommuting preference in every sub-sample were the items "Amount of Telecommuting the Job Allows," and "Allow More Work Done." These two items (taken together) accounted for R-squared values of .39 and higher for each sub-sample.

For the Air Force, two findings of this research are key. First, in every sub-sample, the preference for telecommuting frequency was significantly higher than the frequency respondents felt their jobs allowed. Second, from Table 5-2, over 48% of every sample and sub-sample feel that their jobs would allow them to telecommute 1-3

days a month, however, the percentage drops off sharply as frequency increases above that amount. These results will help AF/DP to develop policy guidance for telecommuting programs throughout the Air Force.

Appendix A: Survey Cover Sheet

22 APR 1998

MEMORANDUM FOR SURVEY PARTICIPANTS


FROM: HQ USAF/DPC
1040 Air Force Pentagon
Washington, DC 20330-1040

SUBJECT: Survey on Telecommuting

AF/DP is in the process of developing guidance for an Air Force telecommuting program. In order to make the program better suit your needs, we are asking for your input through the attached survey. Information gathered from this survey will be used by AF/DP to tailor Air Force guidance on telecommuting to fit the needs of Air Force members. Participation in this survey is voluntary and nonparticipation will not result in any adverse action against you.

For the purpose of this survey, telecommuting can be defined as any period of time you take work home from the office to do at home. These options range from taking work home to do after hours or over the weekend, all the way to doing all of your work at home. Please answer the questions based on the type of telecommuting option you would anticipate using. As in any study, the reliability of the findings depends heavily on the cooperation of each person surveyed, so please give your answers some reflection.

Please indicate your answers to the survey questions on the attached scan-tron sheet using a #2 pencil and return it in the enclosed envelope. If you have any questions regarding this survey, please contact Capt Joseph L. Wolfkiel at DSN 785-3375 or commercial (937) 255-3375. We greatly appreciate your cooperation.


SANDRA G. GRESE
Director
Civilian Personnel Policy
and Personnel Plans

Attachment:
Survey (AFPC Survey Control Number
USAF SCN 98-27)

Appendix B: Survey Instrument

1. What is your gender? 1. Male 2. Female
2. What is your marital status? 1. Married 2. Unmarried
- How many children are in your household aged :
- | | | | | |
|---------------------|----------------|------------|---------------|-------------------------|
| 3. 0-5 years old: | 1. No children | 2. 1 child | 3. 2 children | 4. More than 2 children |
| 4. 6-10 years old: | 1. No children | 2. 1 child | 3. 2 children | 4. More than 2 children |
| 5. 11-15 years old: | 1. No children | 2. 1 child | 3. 2 children | 4. More than 2 children |
| 6. 16-20 years old: | 1. No children | 2. 1 child | 3. 2 children | 4. More than 2 children |
7. Is there anyone in your household (other than preschoolers) who needs special care?
1. Yes 2. No
8. What is your age?
1. 20 or younger 3. 31-40 5. 51-60
2. 21-30 4. 41-50 6. Over 60
9. Which one of the following best describes your occupation?
1. Manager/administration 4. Clerical/admin support
2. Professional/technical 5. Production/construction/crafts
3. Services/repair
10. Are You:
1. Officer 4. GS Civilian
2. Enlisted 5. WG Civilian
3. SES Civilian 6. None of the above
11. Considering the requirements of your current job, how much do you think the nature of your job would allow you to telecommute?
1. Less than once a month 5. 5 days a week
2. About 1-3 days a month 6. Occasional partial days
3. 1-2 days a week 7. Strictly for overtime
4. 3-4 days a week 8. Not at all
12. Assuming that there are no work-related constraints, how often would you like to telecommute?
1. Less than once a month 5. 5 days a week
2. About 1-3 days a month 6. Occasional partial days
3. 1-2 days a week 7. Strictly for overtime
4. 3-4 days a week 8. Not at all

Please rate how much you agree with each of the following potential advantages of telecommuting?

Rating Scale: Strongly disagree Disagree Neutral Agree Strongly agree

1 2 3 4 5

13. Telecommuting will allow me to have more time for myself.
14. Telecommuting will reduce the stress of commuting.
15. Telecommuting will allow me to get more work done.
16. Telecommuting will reduce the stress I experience in the main office.
17. Telecommuting will make it easier to handle dependent (child or adult) care.
18. Telecommuting will allow me to have more independence.

Rating Scale:

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	2	3	4	5

19. Telecommuting will allow me to spend more time with my family.
20. Telecommuting will make it easier to pursue educational or personal interests.
21. Telecommuting will allow me to have more control over my physical working environment.
22. Telecommuting will allow me to be able to work while temporarily disabled.
23. Telecommuting will allow me to be able to work while permanently disabled.
24. Telecommuting will allow me to be able to work instead of taking parental leave.
25. Telecommuting will reduce or eliminate my normal commute time.

How much do you agree with the following disadvantages of telecommuting? (Please rate each item)

26. In general, I prefer the *social* interaction found at the conventional workplace.
27. I prefer the *professional* interaction found at the conventional workplace.
28. I use my commute time productively.
29. Working at home may increase family conflicts.

How much do you agree with the importance of each of the advantages and disadvantages of the telecommuting environment:

30. It is important for me to have to have more time for myself.
31. It is important for me to reduce the stress of commuting.
32. It is important for me to get more work done.
33. It is important for me to reduce the stress I experience in the main office.
34. It is important for me to make it easier to handle dependent (child or adult) care.
35. It is important for me to have more independence.
36. It is important for me to spend more time with my family.
37. It is important for me to pursue educational or personal interests.
38. It is important for me to have more control over my physical working environment.
39. It is important for me to be able to work while temporarily disabled
40. It is important for me to be able to work while permanently disabled
41. It is important for me to be able to work instead of taking parental leave
42. It is important for me to have the *social* interaction found at the conventional workplace.
43. It is important for me to have the *professional* interaction found at the conventional workplace.
44. The time I spend commuting is important to me.
45. It is important to me to decrease family conflicts at home.

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Vita

Capt Joseph L. Wolfkiel was born on 13 September 1966 in Walla Walla, Washington. He graduated from Walla Walla High School in 1985 and entered undergraduate studies at the University of Portland in Portland, Oregon. He graduated with a Bachelor of Science degree in Electrical Engineering in December 1989. He received his commission on 18 December 1989 from the University of Portland Air Force Reserve Officer Training Corps (ROTC) Detachment 695.

After completing Beginning Communication Officer Training at Keesler Air Force Base (AFB) Mississippi, he reported to his first assignment as a Wideband Systems Engineer at Tinker AFB, Oklahoma. His second assignment was at Kirtland AFB, New Mexico, where he served as a Military Satellite Communications Effectiveness Analyst and as a Test and Evaluation Policy Manager. In April 1997, he entered the School of Logistics and Acquisition Management, Air Force Institute of Technology.

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The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. **Please return completed questionnaire to: AIR FORCE INSTITUTE OF TECHNOLOGY/LAC, 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765.** Your response is **important**. Thank you.

1. Did this research contribute to a current research project? a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?
a. Yes b. No

3. **Please estimate** what this research would have cost in terms of manpower and dollars if it had been accomplished under contract or if it had been done in-house.

Man Years _____ \$ _____

4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

a. Highly b. Significant c. Slightly d. Of No
Significant Significant Significance

5. Comments (Please feel free to use a separate sheet for more detailed answers and include it with this form):

Name and Grade

Organization

Position or Title

Address